2005 FINAL PROJECT REPORT

Microbial Source Tracking And Virginia's Beach Monitoring Program

MEMORANDUM OF AGREEMENT (No. 601-617-93276-05-VATECH)

Between

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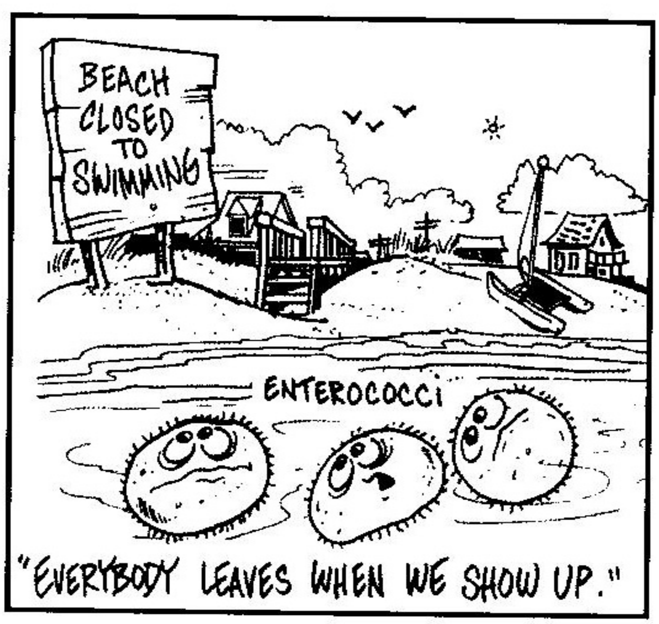


Project Summary

The goal in 2005 was assess in detail the possible sources of fecal contamination at Virginia's public beaches that experienced frequent swimming advisories in 2004, and to evaluate each beach with respect to features or sources that might contribute to fecal pollution in the water. Those beaches that the 2004 project results indicated were problematic (7 of 16 total) included Anderson, Buckroe, Fairview, Hilton, Huntington, King-Lincoln, and Norfolk. All seven beaches were damaged by Hurricane Isabel in September 2003, and major beach restoration activities occurred throughout 2004 and into 2005 at most of damaged beaches. It was anticipated that project results from 2004 might not have much bearing on 2005 at a few of the beaches (*e.g.*, Buckroe and Norfolk) since the shape of those beaches was changed by the restoration projects. Six of the seven beaches (excluding Fairview) were evaluated in 2005 by sampling twice a month (first and third weeks) for six months (April through September, 12 total samplings) at multiple locations per beach; a grid-sampling system was employed in August at four beaches (Anderson, Hilton, Huntington, and King-Lincoln) to determine if the fecal pollution at each beach originated from any particular direction; and split-samples were collected in August at nine beaches with VDH personnel and monitoring was performed both at the labs that VDH used and at VIMS (by Dr. Hagedorn) to cross-check and validate the results. The grid system was not used at Buckroe and Norfolk as these beaches had no posted advisories by August (and had none for the entire 2005 season). Fairview was excluded from the bi-weekly sampling as no beach improvements had been made, and was evaluated by having the VDH-Division of Shellfish Sanitation (DSS) lab in White Stone send the *Enterococcus* cultures from any sample that exceeded standards to Dr. Hagedorn's lab at Virginia Tech for source tracking analysis.

Virginia's beaches were generally in better condition in 2005 than they had been in 2004, and the VDH sampling in 2005 resulted in fewer total swimming advisories (see links to 2004 and 2005 beach statistics at http://www.vdh.state.va.us/epi/dzeepage/BeachMonitoring.asp). For example, the seven beaches designated as problematic by the 2004 results (listed above) had 26 posted advisories in 2004 as compared to 13 advisories (50.0% fewer) in 2005. Microbial Source Tracking (MST) was used to classify isolates of *Enterococcus* as being from human, bird, dog, or wildlife sources, and fluorometry (detection of optical brighteners in detergents from sewers and septic drainfields) was employed as a chemical method to differentiate between human and non-human sources of pollution. Based on the 2004 results that human sources of pollution were present at several beaches, investigations by officials from Hampton, Newport News, and Hampton Roads Sanitation District identified probable sources of the pollution and took steps to eliminate the problems. Sampling in 2005 confirmed the success of these efforts (reduction in the level of pollution from human sources) and demonstrated improved water quality conditions at beaches where post-hurricane restoration projects were undertaken. A direction could be assigned to the pollution at three of the four beaches where the grid system was employed, and the cross-validation monitoring results from the labs used by VDH and Dr. Hagedorn's results from VIMS were in complete agreement. For remaining nine beaches that were not examined in detail in 2005, seven had no advisories over the summer and the remaining two had only three advisories combined. The following sections describe in detail what was done and the results of the 2005 project for each of Virginia's 16 public beaches.

1. Peninsula Health District

1. A. King-Lincoln Park Beach

King-Lincoln Beach is approximately 300-yards long, although the exact boundaries are not apparent. The beach extends southwest to northeast along the North Bank of the James River. The park is flanked on the north by the Aqua Vista apartment complex (adjacent to roughly 50 yards of beach) and contains a wooden pier on the northern end that was destroyed by Hurricane Isabel in 2003 but had been completely rebuilt by the summer of 2005 (see picture below). The remaining 250 or so yards of this beach are south of the pier and is adjacent to King-Lincoln Park. People rarely swim in the water at this beach and the shoreline is not in good condition, but fishing activity has increased with the new pier and large numbers of shore birds were frequently observed around or on the pier in 2005. Samples were taken weekly over the 2005 beach season by the Peninsula Health District staff at the northeastern end of the beach just north of the pier. Additional samples were collected twice a month for six months by the VT staff, from April through September, at the southern side of the pier (King-Lincoln A), from the northern side of the pier (same as the VDH sampling location, King-Lincoln B), and from a storm drain outfall (King-Lincoln SW) found about 20 yards off the beach, north of and behind the pier. The storm drain was observed multiple times over the summer, and flows only after rainfall events. King-Lincoln Park posted three advisories during the summer of 2004 and there were three posted advisories in 2005 (one in June and two in August).

For the six tables on the following pages (monitoring and source tracking results for each of the three sampling sites), the date followed by an "A" (for example, 0405A) indicates that the sample was collected the first week of each month, April thru September, and the date followed by a "B" indicates the sample was collected the third week of each month. For King-Lincoln A (southern side of the pier) there were no counts that exceeded the standard (Table 1), and the major source of the *Enterococcus* isolates was wildlife (38.9% of the total, Table 4), with birds and dogs as secondary sources (30.1% and 22.0%, respectively, Table 4). Fourteen isolates were classified as human in origin, with 13 of the 14 being recovered in April and May. Only 1 human isolate was found after those months. For King-Lincoln B (northern side of the pier) there were two counts that exceeded the standard, one in August and one in September (Table 2), and the major source of the *Enterococcus* isolates was wildlife (32.7% of the total), with birds and dogs as secondary sources (29.5% and 27.3%, respectively, Table 5). Seventeen isolates were classified as human in origin, and all 17 were recovered in April and May. The bi-weekly sampling by the VT staff did not result in high counts for June, although the weekly monitoring by the VDH staff did result in a 3-day advisory for June. The VT samples did pick up the high counts in August that were also found by the VDH sampling, resulting in two August advisories.

For King-Lincoln SW (storm drain outfall on northern side of the pier) there were four of six counts that exceeded the standard Table 3), and the major source of the *Enterococcus* isolates was birds (42.1% of the total), with dogs as the secondary source (25.0%) and humans and wildlife as minor sources (17.1% and 15.6%, respectively, Table 6). Eleven isolates were classified as human in origin, with 9 of the 11 being recovered in April, May, and June. Only 2 human isolates were found after those months. Water flowed from the storm drain sporadically (explaining why only 6 samples were obtained), and it is apparent from Tables 3 and 6 that the storm drain effluent in May and June was a major problem, based on high *Enterococcus* counts and optical brightener readings and human-origin isolates.

Table 1. Monitoring results for King-Lincoln A.

Collection Date	Location*	Optical Brighteners	Tidal Level	cfu/100ml (Ent)
0405A**	King-Lincoln A	36.5	Low-in	10
0405B	King-Lincoln A	30	Low-in	25
0505A	King-Lincoln A	26	Low-out	24
0505B	King-Lincoln A	22.6	Low-out	15
0605A	King-Lincoln A	22.9	High-in	8
0605B	King-Lincoln A	23.3	Low-out	24
0705A	King-Lincoln A	20.1	Mid-out	4
0705B	King-Lincoln A	39.7	High-out	33
0805A	King-Lincoln A	28.3	High-out	15
0805B	King-Lincoln A	25.5	High	84
0905A	King-Lincoln A	27.6	Low-out	10
0905B	King-Lincoln A	20.3	High –in	4

*King-Lincoln A collected from the southern side of the pier.
**Sample A collected 1st week and sample B collected 3rd week of each month.

Table 2. Monitoring results for King-Lincoln B.

Collection Date	Location*	Optical Brightener	Tidal Level	cfu/100ml (Ent)
0405A**	King-Lincoln B	33.3	Low-in	10
0405B	King-Lincoln B	28.2	Low-in	20
0505A	King-Lincoln B	27.2	Low-out	62
0505B	King-Lincoln B	17.2	Low-out	8
0605A	King-Lincoln B	21.7	High-in	0
0605B	King-Lincoln B	22.9	Low-out	26
0705A	King-Lincoln B	20.3	Mid-out	4
0705B	King-Lincoln B	25.1	High-out	27
0805A	King-Lincoln B	26.2	High-out	13
0805B	King-Lincoln B	**28**	**High**	**102**
0905A	King-Lincoln B	**26.9**	**Low-out**	**335**
0905B	King-Lincoln B	21.3	High –in	9

*King-Lincoln B collected from the northern side of the pier.
**Sample A collected 1st week and sample B collected 3rd week of each month.

During the summer of 2005, city engineers worked extensively on the storm drain system from the Aqua Vista apartment complex to identify and resolve cross-connections with the sewer system, collect and remove trash and debris that clogged some drains, and redirect stream water that could enter the storm drains during high rainfall events. These efforts contributed to the lack of flow from the storm drain outfall on the beach during the months of July, August, and September (only one sample was collected over those months, Tables 3 and 6).

Fluorometry results (detection of optical brighteners [OB] from detergents) were inconclusive at this beach, except for the samples from the storm drain outfall. The presence of a human signature was not associated with the swimming advisory postings in June and August, but there is little doubt that the human isolates that were found in the storm drain water contributed to the occasional human isolates found in the beach samples. For the transect sampling at this beach (Table 7), the *Enterococcus* numbers were low but dispersed over the entire grid. The higher counts were adjacent to the shore, and on the north side of the grid, towards Anderson Park Beach. Slightly higher counts were also obtained on the south transect that was nearest to the fishing pier. In summary, it appears that alterations to the storm drain system in the apartment complex have eliminated the human-origin pollution. However, this beach will still probably experience occasional advisories as dog wastes were frequently observed on the northern part of the beach near the apartments and shore birds appeared to be attracted to the fishing pier, especially to trash that had been left on the pier and was observed on several trips.

Table 3. Monitoring results for King-Lincoln SW.

Collection Date	**Location***	**Optical Brightener**	**Tidal Level**	**cfu/100ml (Ent)**
0405A**	King-Lincoln SW	-	Low-in	-
0405B	King-Lincoln SW	23.1	Low-in	0
0505A	King-Lincoln SW	**230**	**Low-out**	**2,680**
0505B	King-Lincoln SW	**162**	**Low-out**	**17,200**
0605A	King-Lincoln SW	34.1	High-in	25
0605B	King-Lincoln SW	**232**	**Low-out**	**2,460**
0705A	King-Lincoln SW	-	Mid-out	-
0705B	King-Lincoln SW	-	High-out	-
0805A	King-Lincoln SW	-	High-out	-
0805B	King-Lincoln SW	26.1	High	100
0905A	King-Lincoln SW	-	Low-out	-
0905B	King-Lincoln SW	-	High –in	-

*King-Lincoln SW collected from the storm drain outfall.
**Sample A collected 1st week and sample B collected 3rd week of each month.

Table 4. Microbial source tracking results for King-Lincoln A.

Collection Date	**Location***	**Bird**	**Human**	**Pets**	**Wildlife**	**Total**
0405A**	King-Lincoln A	2	3	1	2	8
0405B	King-Lincoln A	1	6	7	2	16
0505A	King-Lincoln A	2	1	1	12	16
0505B	King-Lincoln A	0	3	0	13	16
0605A	King-Lincoln A	0	0	0	0	0
0605B	King-Lincoln A	9	1	3	10	23
0705A	King-Lincoln A	4	0	5	6	15
0705B	King-Lincoln A	6	0	4	3	13
0805A	King-Lincoln A	7	0	3	6	16
0805B	King-Lincoln A	3	0	4	1	8
0905A	King-Lincoln A	9	0	4	3	16
0905B	King-Lincoln A	5	0	3	4	12
Total	**King-Lincoln A**	**48**	**14**	**35**	**62**	**159**
%		***30.2***	***8.8***	***22.0***	***39.0***	

*King-Lincoln A collected from the southern side of the pier.
**Sample A collected 1st week and sample B collected 3rd week of each month.

Table 5. Microbial source tracking results for King-Lincoln B.

Collection Date	Location*	Bird	Human	Pets	Wildlife	Total
0405A**	King-Lincoln B	0	4	9	3	16
0405B	King-Lincoln B	2	8	3	3	16
0505A	King-Lincoln B	5	5	2	4	16
0505B	King-Lincoln B	6	0	1	9	16
0605A	King-Lincoln B	0	0	0	0	0
0605B	King-Lincoln B	8	0	10	5	23
0705A	King-Lincoln B	4	0	6	6	16
0705B	King-Lincoln B	7	0	3	6	16
0805A	King-Lincoln B	3	0	4	9	16
0805B	King-Lincoln B	5	0	5	4	16
0905A	King-Lincoln B	8	0	4	4	16
0905B	King-Lincoln B	6	0	3	7	16
Total	**King-Lincoln B**	**54**	**17**	**50**	**60**	**183**
%		***29.5***	***9.3***	***27.3***	***32.8***	

*King-Lincoln B collected from the northern side of the pier.
**Sample A collected 1st week and sample B collected 3rd week of each month.

Table 6. Microbial source tracking results for King-Lincoln SW.

Collection Date	Location*	Bird	Human	Pets	Wildlife	Total
0405A**	King-Lincoln SW	0	0	0	0	0
0405B	King-Lincoln SW	0	4	12	0	16
0505A	King-Lincoln SW	7	4	0	5	16
0505B	King-Lincoln SW	14	0	0	2	16
0605A	King-Lincoln SW	6	3	4	3	16
0605B	King-Lincoln SW	5	6	4	1	16
0705A	King-Lincoln SW	0	0	0	0	0
0705B	King-Lincoln SW	0	0	0	0	0
0805A	King-Lincoln SW	0	0	0	0	0
0805B	King-Lincoln SW	4	2	6	4	16
0905A	King-Lincoln SW	0	0	0	0	0
0905B	King-Lincoln SW	0	0	0	0	0
Total	**King-Lincoln SW**	**27**	**11**	**16**	**10**	**64**
%		***42.2***	***17.2***	***25.0***	***15.6***	

*King-Lincoln SW collected from the storm drain outfall.
**Sample A collected 1st week and sample B collected 3rd week of each month.

Enterococcus isolates were sent to the VT lab for source tracking from the Health District on three occasions over the summer of 2006. The isolates were similar to those presented in Table 5, above, classified primarily as being from birds, wildlife, and dogs (primary contributors), with a few identified as originating from humans (secondary contributor).

Table 7. *Enterococcus* counts on four transects at King-Lincoln B (August 2005).
(North is to the left of the transects, in the direction of Anderson Park Beach)

DEEPER WATER

Transect 1	Transect 2	Transect 3	Transect 4
3m – 76*	3m – 53	3m – 34	3m – 85
6m – 92	6m – 25	6m – 32	6m – 96
9m – 117	9m – 27	9m – 18	9m – 83
12m – 120	12m – 10	12m – 26	12m – 42
15m – 84	15m – 33	15m – 10	15m – 55

PIER

BEACH

**Enterococcus* counts, (CFUs/100ml).

Each transect was obtained with a 15m rope that was marked at one meter intervals. The rope was stretched out from the edge of the shore, and then water samples were collected at each 3m, to the end of the rope (15m). Water samples were taken midway between the surface of the water and the bottom, by first measuring the water depth to determine the midway point. Transect 4 was a few meters away from the fishing pier (see following picture). The distance between each transect was 10 feet (3.3m).

The new fishing pier built at King-Lincoln Park in early 2005. Structures like piers attract birds, especially when trash is dumped on the end of the pier. Trash receptacles are needed at this beach.


Northern part of the beach area between the pier and the apartments. The beach was often littered with trash, including soiled diapers and dog wastes. The storm drain is out of sight to the left.

Plans for King Lincoln Park Beach in 2006

Sampling by the VT staff will concentrate on the northern end of the beach to confirm that the storm drain is no longer a problem at this beach (disappearance of isolates of human origin), to assess the effects of the engineering work on drainages from the apartment complex, to evaluate the impact on water quality of dog wastes on the beach and shore birds attracted by the new fishing pier. Samplings will be coordinated with the VDH staff so that additional collections can be made (by either VDH or VT staff) in a "quick response" mode whenever advisories are posted in an attempt to relate advisories to certain conditions or events such as tides, storms, wind direction, and bird patterns. This should help explain the origins of any high *Enterococcus* counts that might result in sporadic advisories at this beach.

1. B. Anderson Park Beach

Anderson Beach is approximately 600-yards long, although the exact boundaries are not apparent when walking the beach. The beach extends southwest to northeast along the North Bank of the James River. The park is flanked on the north by a waterway that leads into a small marina called Peterson's Yacht Basin. A small park (Monitor-Merrimac Overlook) with a fishing pier is just NE of the entrance to the yacht basin. Several large apartment complexes (Christopher's Shores and Stuart Gardens) are adjacent to the beach area. Anderson Park Beach borders King-Lincoln Park on the SW end, but there is no direct connection and the actual boundaries are not clear. People rarely swim in the water at this beach, the shoreline is not in good condition, and large numbers of shore birds were frequently observed on various parts of the beach. Samples were taken weekly over the 2005 beach season by the Peninsula Health District staff at one central location on the beach (designated as Anderson A). Additional samples were collected twice a month for six months by the VT staff, April through September, from the single location used by the VDH staff, plus a second location (designated Anderson B) 50 yards south of Anderson A, and a third location, from a storm drain outfall near the NE end of the beach, north of Anderson A (and is submerged at high tide, designated as Anderson NE). Anderson Beach posted four swimming advisories during the summer of 2004, but only one swimming advisory in 2005 (occurred in late May). In the fall of 2004, a large concentration of optical brighteners was found in the water above Anderson NE and below the entrance to the marina. Based on these results, city engineers excavated into an old sewer line that was no longer in use adjacent to the shore. They found that the cap sealing off the old sewer line had failed (apparently several years ago), resulting in raw sewage entering the old sewer line and then seeping out into the water above the beach area. The old line was permanently closed and sealed, resulting in the disappearance of the optical brighteners in the water. This probably contributed greatly to the lower number of advisories at Anderson Beach in 2005.

For the six tables on the following pages (monitoring and source tracking results for each of the three sampling sites), the date followed by an "A" (for example, 0405A) indicates that the sample was collected the first week of each month, April thru September, and the date followed by a "B" indicates the sample was collected the third week of each month. For Anderson A there was only one sample that exceeded the standard (September [in bold], Table 1), and the major sources of the *Enterococcus* isolates were birds (47.9% of the total, Table 4), with wildlife and dogs as secondary sources (23.9% for both, Table 4). Six isolates were classified as human in origin (4.3%), with 5 of the 6 being recovered in May. For Anderson B (50 yards south of A) there were two samples that exceeded the standard (May and September [in bold], Table 2), and the major source of the *Enterococcus* isolates was birds (49.2% of the total, Table 5), with wildlife and dogs as secondary sources (29.0% and 21.8%, respectively, Table 5). No isolates were classified as human. The bi-weekly sampling by the VT staff at Anderson B produced high counts for May, the same month where the only swimming advisory, based on weekly monitoring by the VDH staff, was posted. The VT samples from Anderson A and B produced high counts in September, but VDH stopped sampling at the end of August and did not collect samples after that.

For Anderson NE (storm drain outfall) there were seven of the eleven samples that exceeded the standard (in bold, Table 3), and the major sources of the *Enterococcus* isolates were birds (37.5% of the total, Table 6), with dogs and wildlife as the secondary sources (25.6% for both, Table 6) and humans as a minor source (11.3%, Table 6).

Table 1. Monitoring results for Anderson A.

Collection Date	Location*	Optical Brighteners	Tidal Level	cfu/100ml (Ent)
0405A**	Anderson A	36.0	Mid-in	0
0405B	Anderson A	27.9	Low-in	5
0505A	Anderson A	27.6	Low-in	48
0505B	Anderson A	21.0	Low-out	15
0605A	Anderson A	23.0	High-in	5
0605B	Anderson A	20.9	Low-in	34
0705A	Anderson A	24.5	Mid - out	65
0705B	Anderson A	27.0	High -out	20
0805A	Anderson A	27.7	High -out	17
0805B	Anderson A	29.5	High	80
0905A	Anderson A	**27.5**	**Low-in**	**360**
0905B	Anderson A	21.0	High-in	5

*Anderson A is where the VDH staff collect samples.
**Sample A collected 1st week and sample B collected 3rd week of each month.

Table 2. Monitoring results for Anderson B.

Collection Date	Location*	Optical Brightener	Tidal Level	cfu/100ml (Ent)
0405A**	Anderson B	33.3	Mid-in	25
0405B	Anderson B	28.9	Low-in	45
0505A	Anderson B	**30.6**	**Low-in**	**114**
0505B	Anderson B	18.1	Low-out	13
0605A	Anderson B	25.8	High-in	0
0605B	Anderson B	22.4	Low-in	74
0705A	Anderson B	22.1	Mid - out	28
0705B	Anderson B	31.4	High -out	12
0805A	Anderson B	28.2	High -out	16
0805B	Anderson B	24.2	High	80
0905A	Anderson B	**27.3**	**Low-in**	**130**
0905B	Anderson B	20.9	High -in	11

*Anderson B collected 50 yards south of Anderson A.
**Sample A collected 1st week and sample B collected 3rd week of each month.

The storm drain is clearly a problem at Anderson Beach, as the *Enterococcus* counts for the seven samples that exceeded the standard ranged from 220 to 5,040 (Table 3). Fluorometry results (detection of optical brighteners [OB] from detergents) were inconclusive at this beach, except for one sample from the storm drain outfall (a reading of 149 in 06/05B, the same sample where the highest counts [5,040] were recorded). Four of the storm drain samples were below the standard, indicating that whatever sources are contributing to the high counts from the storm drain, they are sporadic and not present at all times. Human isolates were found at both Anderson A and the storm drain in May, when the swimming advisory was posted. There is little doubt that the human isolates that were found in the storm drain water contributed to the occasional human isolates found in the beach samples at Anderson A. Anderson B was further away from the storm drain and no human isolates were found at that location. For the July transect sampling at this beach (Anderson A, Table 7), the *Enterococcus* numbers low to high and dispersed over the entire grid. The higher counts were towards the open water and on the north side of the grid, towards the storm drain. In summary, it appears that the repairs to the leaking sewer line reduced both the counts and the magnitude of the human signature in water samples taken at Anderson Beach in 2005. The storm drain could cause problems, especially in a wet summer, and dog wastes are clearly an issue that needs to be addressed.

Table 3. Monitoring results for Anderson NE.

Collection Date	Location*	Optical Brightener	Tidal Level	cfu/100ml (Ent)
0405A**	Anderson NE	**50.5**	**Low-in**	**1,560**
0405B	Anderson NE	16.2	Low-out	0
0505A	Anderson NE	**40.3**	**Low-in**	**900**
0505B	Anderson NE	**33.3**	**Low-out**	**380**
0605A	Anderson NE	21.2	High-in	55
0605B	Anderson NE	**149.0**	**Low-in**	**5,040**
0705A	Anderson NE	**33.8**	**Mid - out**	**680**
0705B	Anderson NE	**28.0**	**High -out**	**840**
0805A	Anderson NE	31.7	High -out	60
0805B	Anderson NE	23.8	High	30
0905A	Anderson NE	**26.4**	**Low-in**	**220**
0905B	Anderson NE	No sample	High -in	No sample

*Anderson NE collected from the storm drain outfall.
**Sample A collected 1st week and sample B collected 3rd week of each month.

Table 4. Microbial source tracking results for Anderson A.

Collection Date	Location*	Bird	Human	Pets	Wildlife	Total
0405A**	Anderson A	0	0	0	0	0
0405B	Anderson A	4	0	0	1	5
0505A	Anderson A	6	3	4	3	16
0505B	Anderson A	6	2	6	1	15
0605A	Anderson A	4	0	1	0	5
0605B	Anderson A	9	1	3	3	16
0705A	Anderson A	5	0	5	6	16
0705B	Anderson A	9	0	4	3	16
0805A	Anderson A	7	0	3	6	16
0805B	Anderson A	8	0	4	4	16
0905A	Anderson A	9	0	4	3	16
0905B	Anderson A	1	0	0	4	5
Total	Anderson A	**68**	**6**	**34**	**34**	**142**
%		***47.9***	***4.3***	***23.9***	***23.9***	**100**

*Anderson A is the location where the VDH staff collect samples.
**Sample A collected 1st week and sample B collected 3rd week of each month.

Table 5. Microbial source tracking results for Anderson B.

Collection Date	Location*	Bird	Human	Pets	Wildlife	Total
0405A**	Anderson B	7	0	6	3	16
0405B	Anderson B	8	0	3	5	16
0505A	Anderson B	10	0	2	4	16
0505B	Anderson B	6	0	1	6	13
0605A	Anderson B	0	0	0	0	0
0605B	Anderson B	6	0	6	4	16
0705A	Anderson B	4	0	6	6	16
0705B	Anderson B	7	0	2	7	12
0805A	Anderson B	9	0	4	3	16
0805B	Anderson B	5	0	4	5	16
0905A	Anderson B	8	0	4	4	16
0905B	Anderson B	3	0	2	6	11
Total	Anderson B	**90**	**0**	**40**	**53**	**183**
%		***49.2***	***0.0***	***21.8***	***29.0***	**100**

**Anderson B collected 50 yards south of Anderson A.
**Sample A collected 1st week and sample B collected 3rd week of each month.

Table 6. Microbial source tracking results for Anderson NE.

Collection Date	Location*	Bird	Human	Pets	Wildlife	Total
0405A**	Anderson NE	6	0	4	6	16
0405B	Anderson NE	0	0	0	0	0
0505A	Anderson NE	7	4	0	5	16
0505B	Anderson NE	5	2	8	1	16
0605A	Anderson NE	6	3	4	3	16
0605B	Anderson NE	7	1	5	3	16
0705A	Anderson NE	12	0	3	1	16
0705B	Anderson NE	6	2	1	7	16
0805A	Anderson NE	5	3	4	4	16
0805B	Anderson NE	4	3	6	4	16
0905A	Anderson NE	10	0	3	3	16
0905B	Anderson NE	0	0	0	0	0
Total	Anderson NE	**60**	**18**	**41**	**41**	**160**
%		***37.5***	***11.3***	***25.6***	***25.6***	**100**

*Anderson NE collected from the storm drain outfall.
**Sample A collected 1st week and sample B collected 3rd week of each month.

Table 7. *Enterococcus* counts on four transects at Anderson A (July 2005).
(North is to the left of the transects, in the direction of the storm drain.)

DEEPER WATER

Transect 1	Transect 2	Transect 3	Transect 4
15m – 138*	15m – 133	15m – 107	15m – 85
12m – 112	12m – 85	12m – 86	12m – 66
9m – 146	9m – 67	9m – 58	9m – 43
6m – 115	6m – 17	6m – 25	6m – 12
3m – 80	3m – 10	3m – 9	3m – 9

PIER

BEACH

**Enterococcus* counts, (CFUs/100ml).

Each transect was obtained with a 15m rope that was marked at one meter intervals. The rope was stretched out from the edge of the shore, and then water samples were collected at each 3m, to the end of the rope (15m). Water samples were taken midway between the surface of the water and the bottom, by first measuring the water depth to determine the midway point. The distance between each transect was 10 feet (3.3m).

Image 1. Anderson A sampling site location, in between the first and second jetties in the picture. Trash receptacles are needed here. The view is looking south, and the storm drain is out of site to the north of where the picture was taken.


Image 2. Anderson B sampling site location, in between the jetty and the rock breakwater in the picture. The view is looking south, and Anderson A is out of site to the north of where the picture was taken.


Image 3. Michele Monti collecting a sample from the storm drain, August 2005.

Plans for Anderson Beach in 2006

City engineers plan on improving drainage at the beach and attempting to reduce the discharge from the storm drain. Sampling by the VT staff will concentrate on the northern end of the beach to monitor the impact and success of these efforts (reductions in the high counts that are found in the storm drain), and to evaluate the impact on water quality of dog wastes and shore birds on the beach. Samplings will be coordinated with the VDH staff so that additional collections can be made (by either VDH or VT staff) in a "quick response" mode whenever advisories are posted in an attempt to relate advisories to certain conditions or events such as tides, storms, wind direction, and bird patterns. This should help explain the origins of any high *Enterococcus* counts that might result in sporadic advisories at this beach.

1. C. Hilton Beach

Hilton Beach is approximately 100 yards in length, running west to east along the northern bank of the James River. Located behind an elementary school, Hilton Beach is almost completely covered at high tide, and contains a continuously flowing storm drain outfall on the easternmost side of the beach. One sample was collected from Hilton Beach each week from a central location by VDH staff over the 2004 and 2005 beach seasons, west of the storm drain (identified as Hilton 208). In 2005, additional samples were collected twice a month for six months by the VT staff, May through September, from the storm drain outfall on the eastern end of the beach (Hilton SW), from the central area of the beach (same as the VDH sampling location, Hilton 208), and from a location 15 yards east (downstream) from the storm drain outfall (Hilton A).

Hilton Beach posted four swimming advisories and was closed for a total of 63 days through the summer of 2004. Three swimming advisories were posted for the summer of 2005, but the beach was closed for only 8 days. People rarely swim in the water at this beach, and dogs appear to be a problem at certain times as people were frequently observed walking their dogs directly on the beach area. The beach is almost totally submerged at high tide, and any dog wastes left on the beach then become dispersed in the water. Hilton Beach was the most problematic beach of those monitored in 2004, likely due to the storm drain outfall on the eastern end of the beach. In the fall of 2004, city officials discovered sewer pipes from a nearby trailer park that were leaking into the Hilton storm drain, probably contributing to the high human signature obtained during the summer of 2004. Plans were made to repair the storm drain systems prior to the 2005 swimming season, but is in not known if any repairs were actually made. Fishing activity has increased with the new pier and large numbers of shore birds were frequently observed around or on the pier in 2005. These birds could also have an impact on water quality, especially on a beach as small as Hilton.

For the six tables on the following pages (monitoring and source tracking results for each of the three sampling sites), the date followed by an "A" (for example, 0405A) indicates that the sample was collected the first week of each month, April thru September, and the date followed by a "B" indicates the sample was collected the third week of each month. For Hilton A (eastern side of storm drain outfall) there were five samples that exceeded the standard (two in May, one in June, and two in July, Table 1), and the major sources of the *Enterococcus* isolates were birds (56.9% of the total, Table 4), with dogs, wildlife, and humans as secondary sources (15.9%, 14.2%, and 13.1%, respectively, Table 4). Twenty-three isolates were classified as human in origin, with 19 of the 23 being recovered in May and June. Only 4 human isolates were found after June. For Hilton 208 (central location of the beach) there were three samples that exceeded the standard (one each in May, June, and July, Table 2), and the major sources of the *Enterococcus* isolates were birds (53.7% of the total, Table 5), with wildlife and dogs as secondary sources (26.9% and 19.4%, respectively, Table 5). No isolates were classified as human in origin. The bi-weekly sampling by the VT staff indicated that swimming advisories could have been posted in May, June, and July, while the weekly monitoring by the VDH staff resulted in swimming advisories in May and August.

For Hilton SW (storm drain outfall on eastern side of the beach) there were eleven of twelve samples that exceeded the standard (Table 3), and the major sources of the *Enterococcus* isolates were birds (48.4% of the total, Table 6), with humans, wildlife, and pets as secondary sources (20.4%, 16.1%, and 15.1%, respectively, Table 6). Thirty-eight isolates were classified as human in origin, with 24 of the 38 (63%) being recovered in May and June.

Table 1. Monitoring results for Hilton A.

Collection Date	Location*	Optical Brighteners	Tidal Level	cfu/100ml
0405A**	Hilton A	36.4	Low-in	15
0405B	Hilton A	27.1	Low-in	30
0505A	Hilton A	41.5	Mid-out	**1,810**
0505B	Hilton A	27.3	Low-in	**823**
0605A	Hilton A	33.9	Mid-in	70
0605B	Hilton A	29.1	Low-in	**158**
0705A	Hilton A	33.8	Mid-out	**222**
0705B	Hilton A	34.9	High-in	**196**
0805A	Hilton A	40.0	Mid-out	16
0805B	Hilton A	29.0	Low-in	40
0905A	Hilton A	28.0	Low-in	48
0905B	Hilton A	26.2	High-in	12

*Hilton A collected from the eastern side of the storm drain outfall.
**Sample A collected 1st week and sample B collected 3rd week of each month.

Table 2. Monitoring results for Hilton 208.

Collection Date	Location*	Optical Brightener	Tidal Level	cfu/100ml
0405A**	Hilton 208	38.9	Low-in	15
0405B	Hilton 208	27.5	Low-in	15
0505A	Hilton 208	48.5	Mid-out	**2,460**
0505B	Hilton 208	24.5	Low-in	8
0605A	Hilton 208	37.2	Mid-in	90
0605B	Hilton 208	28.4	Low-in	**181**
0705A	Hilton 208	35.0	Mid-out	**256**
0705B	Hilton 208	34.0	High-in	98
0805A	Hilton 208	38.8	Mid-out	58
0805B	Hilton 208	31.5	Low-in	56
0905A	Hilton 208	64.4	Low-in	14
0905B	Hilton 208	26.0	High-in	24

*Hilton 208 collected from the center of the beach area.
**Sample A collected 1st week and sample B collected 3rd week of each month.

For the storm drain outfall, four of the samples had counts greater than 1,000 (Table 3), and two samples had very high counts (41,800 at 0505A, and 136,000 for 0605B). The count of 136,000 was the highest recorded for any sample at any beach in the 2005 project. Fluorometry results (detection of optical brighteners [OB] from detergents) were inconclusive at the two beach samples, but two samples from the storm drain outfall were positive for optical brighteners (the same two samples with the very high counts, Tables 3 and 6). The presence of a human signature was not associated with the swimming advisory postings in May and August, but there is little doubt that the human isolates that were found in the storm drain water contributed to the occasional human isolates found at Hilton A, located downstream from the storm drain outfall.

For the transect sampling at this beach (Table 7), the *Enterococcus* numbers were low but dispersed over the entire grid. The higher counts were adjacent to the shore, and on the east side of the grid, towards the storm drain outfall. In summary, it appears that whatever alterations to the storm drain system (if any) did little to eliminate the human-origin pollution and the high counts from the outfall. Periodic advisories for Hilton Beach should be expected, based on the results from the storm drain, plus dog wastes were frequently observed on the beach at low tide, and shore birds are being attracted to the new fishing pier. All of these add up to future problems for Hilton Beach.

Table 3. Monitoring results for Hilton SW.

Collection Date	Location*	Optical Brightener	Tidal Level	cfu/100ml
0405A**	Hilton SW	47.4	Low-in	**185**
0405B	Hilton SW	43.5	Low-in	**760**
0505A	Hilton SW	**126.0**	**Mid-out**	**41,800**
0505B	Hilton SW	61.9	Low-in	**680**
0605A	Hilton SW	40.4	Mid-in	**645**
0605B	Hilton SW	**237.0**	**Low-in**	**136,000**
0705A	Hilton SW	141	Mid-out	**3,460**
0705B	Hilton SW	58.9	High-in	**1,240**
0805A	Hilton SW	77.1	Mid-out	**540**
0805B	Hilton SW	65.3	Low-in	**115**
0905A	Hilton SW	38.1	Low-in	10
0905B	Hilton SW	30.2	High-in	**130**

*Hilton SW collected from the storm drain outfall.
**Sample A collected 1st week and sample B collected 3rd week of each month.

Table 4. Microbial source tracking results for Hilton A.

Collection Date	Location*	Bird	Human	Pets	Wildlife	Total
0405A**	Hilton A	5	0	1	2	8
0405B	Hilton A	4	0	2	2	16
0505A	Hilton A	8	4	1	3	16
0505B	Hilton A	8	6	0	2	16
0605A	Hilton A	10	0	3	3	16
0605B	Hilton A	9	1	3	3	16
0705A	Hilton A	8	5	2	1	16
0705B	Hilton A	6	4	4	2	16
0805A	Hilton A	7	3	3	3	16
0805B	Hilton A	13	0	3	0	16
0905A	Hilton A	9	0	4	3	16
0905B	Hilton A	5	0	2	1	8
Total	Hilton A	**100**	**23**	**28**	**25**	**176**
%		***56.8***	***13.1***	***15.9***	***14.2***	**100**

*Hilton A collected from the eastern side of the storm drain outfall.
**Sample A collected 1st week and sample B collected 3rd week of each month.

Table 5. Microbial source tracking results for Hilton 208.

Collection Date	Location*	Bird	Human	Pets	Wildlife	Total
0405A**	Hilton 208	6	0	0	2	8
0405B	Hilton 208	3	0	2	3	8
0505A	Hilton 208	12	0	2	2	16
0505B	Hilton 208	4	0	1	3	8
0605A	Hilton 208	10	0	2	4	16
0605B	Hilton 208	8	0	4	4	16
0705A	Hilton 208	6	0	4	6	16
0705B	Hilton 208	7	0	3	6	16
0805A	Hilton 208	9	0	4	3	16
0805B	Hilton 208	7	0	5	4	16
0905A	Hilton 208	4	0	2	2	8
0905B	Hilton 208	10	0	2	4	16
Total	Hilton 208	**86**	**0**	**31**	**43**	**160**
%		***53.7***	***0.0***	***19.4***	***26.9***	**100**

*Hilton 208 B collected from the central beach area.
**Sample A collected 1st week and sample B collected 3rd week of each month.

Table 6. Microbial source tracking results for Hilton SW.

Collection Date	Location*	Bird	Human	Pets	Wildlife	Total
0405A**	Hilton SW	12	0	0	4	16
0405B	Hilton SW	6	4	3	3	16
0505A	Hilton SW	4	7	4	1	16
0505B	Hilton SW	6	6	2	2	16
0605A	Hilton SW	8	3	2	3	16
0605B	Hilton SW	10	2	3	1	16
0705A	Hilton SW	7	7	1	1	16
0705B	Hilton SW	5	4	3	4	16
0805A	Hilton SW	9	3	2	2	16
0805B	Hilton SW	6	2	4	4	16
0905A	Hilton SW	5	0	2	3	10
0905B	Hilton SW	12	0	2	2	16
Total	Hilton SW	**90**	**38**	**28**	**30**	**186**
%		***48.4***	***20.4***	***15.1***	***16.1***	**100**

*Hilton SW collected from the storm drain outfall.
**Sample A collected 1st week and sample B collected 3rd week of each month.

Enterococcus isolates were sent to the VT lab for source tracking from the Health District on two occasions over the summer of 2005. The isolates were similar to those presented in Table 5, above, classified primarily as being from birds, wildlife, and dogs.

Table 7. *Enterococcus* counts on four transects at Hilton 208 (August 2005). (East is to the left of the transects, in the direction of the storm drain outfall.)

DEEPER WATER

Transect 1	Transect 2	Transect 3	Transect 4
15m – 114*	15m – 53	15m – 79	15m – 57
12m – 86	12m – 25	12m – 120	12m – 26
9m – 94	9m – 27	9m – 75	9m – 43
6m – 37	6m – 10	6m – 53	6m – 57
3m – 55	3m – 86	3m – 57	3m – 82

PIER

BEACH

**Enterococcus* counts, (CFUs/100ml).

Each transect was obtained with a 15m rope that was marked at one meter intervals. The rope was stretched out from the edge of the shore, and then water samples were collected at each 3m, to the end of the rope (15m). Water samples were taken midway between the surface of the water and the bottom, by first measuring the water depth to determine the midway point. Transect 4 was a few meters away from the fishing pier (see following picture). The distance between each transect was 10 feet (3.3m).

Image 1. The storm drain outfall on the eastern end of Hilton Beach.

Image 2. Hilton Beach at high tide, when very little of the beach is above water. The storm drain is out of sight to the right, the new fishing pier is on the western end of the beach.

Image 3. The new fishing pier at Hilton Beach.

Plans for Hilton Beach in 2006

Sampling by the VT staff will concentrate on the eastern end of the beach to determine the impact of the storm drain on the "swimming area" at Hilton Beach, and to assess the effects of any engineering work that might be done to reduce the loadings that flow from the storm drain. The outfall could be very problematic in a wetter summer. The other sources of contamination on this beach are apparent, such as dog wastes on the beach and shore birds attracted by the new fishing pier. Samplings will be coordinated with the VDH staff so that additional collections can be made (by either VDH or VT staff) in a "quick response" mode whenever advisories are posted in an attempt to relate advisories to the storm drain, or dogs or birds (or some combination of these).

1. D. Huntington Beach

Huntington Beach is 400yd stretch of beach located on the northern bank of the James River at the War Memorial Museum, and adjacent to the James River Bridge. Since this is a heavily used and popular beach with swimmers, three sampling sites are monitored by the Peninsula Health District along the southern end of the beach, all within a 100 yard-wide swimming area enclosed by buoys. VDH sampling sites for Huntington (205, 206, and 207) were located within the buoyed swimming area, with 205 at the easternmost location, 207 at the westernmost, and 206 in the middle. Each sampling location was separated by approximately 30 yards, and these were sampled weekly by VDH staff over the 2004 and 2005 beach seasons. In 2005 samples were collected twice a month for six months by the VT staff, April through September, from Huntington 205, Huntington 207, and Huntington SW (a storm outfall on the east end of the beach, next to the James River Bridge). The storm drain was seen flowing on several occasions at low tide, and appeared to flow the heaviest after rainfall events.

Huntington Beach posted four swimming advisories and was closed a total of twelve days during the summer of 2004, while there were no advisories in 2005. Between the 2004 and 2005 seasons, officials developed a program for regularly cleaning the beach, collecting and removing trash that might attract birds, and took a more proactive approach with dog owners to collect pet wastes. These efforts certainly contributed to the absence of swimming advisories in 2005.

For the six tables on the following pages (monitoring and source tracking results for each of the three sampling sites), the date followed by an “A” (for example, 0405A) indicates that the sample was collected the first week of each month, April thru September, and the date followed by a “B” indicates the sample was collected the third week of each month. For Huntington 205 there were two samples that exceeded the standard (0505A and 0605B [in bold], Table 1), and the major sources of the *Enterococcus* isolates were birds (83.3% of the total, Table 4), with wildlife and dogs as secondary sources (14.0% and 2.7%, respectively, Table 4). No isolates were classified as human in origin. For Huntington 207 there were also two samples that exceeded the standard, both from the same dates as Huntington 205 (0505A and 0605B [in bold], Table 2), and the major sources of the *Enterococcus* isolates were birds (78.4% of the total, Table 5), with wildlife and dogs as secondary sources (15.3% and 6.3%, respectively, Table 5). No isolates were classified as human. The bi-weekly sampling by the VT staff produced high counts for two dates (Tables 1 and 2), but these counts were not obtained in the weekly monitoring by the VDH staff (sampling by VT and VDH was not conducted on the same day at either time).

For Huntington SW (storm drain outfall) there were seven of the twelve samples that exceeded the standard (in bold, Table 3), and the counts for four of those dates exceeded 1,000cfu/100mL. On two dates the counts were very high (13,500cfu on 0505A and 6,960cfu on 0605B). These were the same two dates that the VT staff obtained high counts for Huntington 205 and 207. Both of these dates followed storm events and the storm outfall at Huntington SW had a substantial flow rate. Had VDH sampled on those exact days, advisories would certainly have resulted. The major sources of the *Enterococcus* isolates were birds (62.5% of the total, Table 6), with wildlife and humans as the secondary sources (19.7% and 11.5%, respectively, Table 6) and dogs as a minor source (6.3%, Table 6). There were 22 isolates identified as human in origin and twenty of these isolates were from four dates, the same four dates where the counts were over 1,000 cfu/100mL (Tables 3 and 6). The presence of a human signature from the storm drain outfall samples, plus the high counts from four samples, indicates that the storm drain could pose a problem at Huntington Beach, especially in a wet summer.

Table 1. Monitoring results for Huntington 205.

Collection Date	Location	OB	Tidal Level	cfu/100ml
0405A*	Huntington 205	36.8	Low-in	0
0405B	Huntington 205	26.1	Low-in	20
0505A	Huntington 205	42.6	Mid/Low	**1,890**
0505B	Huntington 205	26.1	Low-out	8
0605A	Huntington 205	34.3	Mid-in	80
0605B	Huntington 205	43.2	Low-in	**1,470**
0705A	Huntington 205	30.2	Mid-out	90
0705B	Huntington 205	33.9	High-out	30
0805A	Huntington 205	40.3	Mid-out	16
0805B	Huntington 205	31.0	Low-in	14
0905A	Huntington 205	25.0	Low	10
0905B	Huntington 205	26.1	High-in	9

*Sample A collected 1st week and sample B collected 3rd week of each month.

Table 2. Monitoring results for Huntington 207.

Collection Date	Location	OB	Tidal Level	cfu/100ml
0405A*	Huntington 207	38.3	Low-in	5
0405B	Huntington 207	27.2	Low-in	35
0505A	Huntington 207	42.2	Mid/Low	**1,680**
0505B	Huntington 207	53.6	Low-out	15
0605A	Huntington 207	34.0	Mid-in	68
0605B	Huntington 207	36.9	Low-in	**462**
0705A	Huntington 207	31.8	Mid-out	94
0705B	Huntington 207	34.3	High-out	26
0805A	Huntington 207	37	Mid-out	24
0805B	Huntington 207	29.4	Low-in	40
0905A	Huntington 207	27.3	Low	6
0905B	Huntington 207	32.3	High-in	9

*Sample A collected 1st week and sample B collected 3rd week of each month.

Table 3. Monitoring results for Huntington SW.

Collection Date	Location*	OB	Tidal Level	cfu/100ml
0405A**	Huntington SW	83.7	Low-in	30
0405B	Huntington SW	43.5	Low-in	50
0505A	Huntington SW	**172.0**	**Mid/Low**	**13,500**
0505B	Huntington SW	50.0	Low-out	**190**
0605A	Huntington SW	68.4	Mid-in	45
0605B	Huntington SW	**215.0**	**Low-in**	**6,960**
0705A	Huntington SW	**96.7**	**Mid-out**	**540**
0705B	Huntington SW	73.1	High-out	**1,600**
0805A	Huntington SW	**92.9**	**Mid-out**	**220**
0805B	Huntington SW	**89.9**	**Low-in**	**1,450**
0905A	Huntington SW	64.4	Low	80
0905B	Huntington SW	27.5	High-in	40

*Huntington SW collected from the storm drain outfall.
**Sample A collected 1st week and sample B collected 3rd week of each month.

Table 4. Microbial source tracking results for Huntington 205.

Collection Date	Location	Bird	Human	Pets	Wildlife	Total
0405A*	Huntington 205	0	0	0	0	0
0405B	Huntington 205	12	0	0	4	16
0505A	Huntington 205	15	0	0	1	16
0505B	Huntington 205	6	0	1	1	8
0605A	Huntington 205	13	0	0	3	16
0605B	Huntington 205	9	0	2	5	16
0705A	Huntington 205	14	0	0	2	16
0705B	Huntington 205	16	0	0	0	16
0805A	Huntington 205	13	0	0	3	16
0805B	Huntington 205	13	0	0	1	14
0905A	Huntington 205	8	0	0	0	8
0905B	Huntington 205	6	0	1	1	8
Total	Huntington 205	**125**	**0**	**4**	**21**	**150**
%		***83.3***	***0.0***	***2.7***	***14.0***	**100**

*Sample A collected 1st week and sample B collected 3rd week of each month.

Table 5. Microbial source tracking results for Huntington 207.

Collection Date	Location	Bird	Human	Pets	Wildlife	Total
0405A*	Huntington 207	0	0	0	0	0
0405B	Huntington 207	12	0	2	2	16
0505A	Huntington 207	12	0	0	4	16
0505B	Huntington 207	7	0	0	1	8
0605A	Huntington 207	0	0	0	0	16
0605B	Huntington 207	9	0	3	4	16
0705A	Huntington 207	12	0	0	4	16
0705B	Huntington 207	16	0	0	0	16
0805A	Huntington 207	11	0	2	3	16
0805B	Huntington 207	13	0	1	2	16
0905A	Huntington 207	0	0	0	0	0
0905B	Huntington 207	5	0	1	2	8
Total	Huntington 207	**113**	**0**	**9**	**22**	**144**
%		***78.4***	***0.0***	***6.3***	***15.3***	**100**

*Sample A collected 1st week and sample B collected 3rd week of each month.

Table 6. Microbial source tracking results for Huntington SW.

Collection Date	Location*	Bird	Human	Pets	Wildlife	Total
0405A**	Huntington SW	10	0	2	4	16
0405B	Huntington SW	12	0	1	3	16
0505A	Huntington SW	7	**6**	0	3	16
0505B	Huntington SW	14	1	1	0	16
0605A	Huntington SW	12	0	0	4	16
0605B	Huntington SW	5	**7**	1	3	16
0705A	Huntington SW	9	1	2	4	16
0705B	Huntington SW	7	**4**	2	3	16
0805A	Huntington SW	12	0	1	3	16
0805B	Huntington SW	9	**3**	1	3	16
0905A	Huntington SW	11	0	0	5	16
0905B	Huntington SW	12	0	1	3	16
Total	Huntington SW	**120**	**22**	**12**	**38**	**192**
%		***62.5***	***11.5***	***6.3***	***19.7***	**100**

*Huntington SW collected from the storm drain outfall.
**Sample A collected 1st week and sample B collected 3rd week of each month.

The storm drain is clearly a problem at Huntington Beach, as the *Enterococcus* counts for the seven samples that exceeded the standard ranged from 220 to 13,500 (Table 3). Fluorometry results (detection of optical brighteners [OB] from detergents) were inconclusive at this beach at the two sampling sites from the swimming areas (Huntington 205 and 207). From the storm drain, however, two of the samples were positive for optical brighteners (readings above 100, the two samples with the highest monitoring counts, 0505A and 0605B, Table 3), and three others were almost positive (above 90). Five of the storm drain samples were below the standard, indicating that whatever sources are contributing to the high counts and optical brighteners from the storm drain, they are sporadic and not present at all times. Based on the 2005 sampling, the high counts from the outfall appear to be related to storm events and high flow levels.

For the August transect sampling at this beach (Huntington 206, Table 7), the *Enterococcus* numbers were low to high and dispersed over the entire grid. The higher counts were towards the open water and on the east side of the grid, towards the storm drain. In summary, it appears that the birds frequently observed at Huntington Beach are apparently not causing a problem with water quality. They certainly were not in 2005. Dogs were not a problem, and the improvements to the beach appear to have been successful in reducing the number of advisories at this beach. The storm drain should be addressed, as the high counts, the human signature, and detection of optical brighteners are all confirmation that human-origin pollution is entering the storm drain at some location removed from the beach.

Table 7. Transect sampling for Huntington Beach, at Site 206 (east is to the left of the transects, in the direction of the James River Bridge).

DEEPER WATER-CENTER OF SWIMMING AREA

Transect 1	**Transect 2**	**Transect 3**	**Transect 4**
15m – 120*	15m – 101	15m – 112	15m – 64
12m – 56	12m – 78	12m – 75	12m – 36
9m – 34	9m – 47	9m – 26	9m – 28
6m – 14	6m – 19	6m – 10	6m – 22
3m – 47	3m – 12	3m – 17	3m – 15

WEST

BEACH

**Enterococcus* counts, (CFUs/100mL).

Each transect was obtained with a 15m rope that was marked at one meter intervals. The rope was stretched out from the edge of the shore, and then water samples were collected at each 3m, to the end of the rope (15m). Water samples were taken midway between the surface of the water and the bottom, by first measuring the water depth to determine the midway point. The distance between each transect was 10 feet (3.3m).

Image 1. The beach is bordered on the east by the James River Bridge, and the picture shows a large storm drain that is on the eastern end of the beach, next to the bridge causeway.

Image 2. Marsh ducks and Herring Gulls in the designated swimming area at Huntington Beach.

Image 3. This picture shows the swimming area boundaries (inside the yellow floats), looking west, towards the public boat ramp at the western end of the beach. This beach is popular with birds as well as swimmers; there are Greater Black-Backed Gulls and pigeons in the foreground, and a flock of ducks in the background. This is a well-maintained beach and the grounds are kept very clean. It is not clear what attracts such numbers of birds to the beach. For example, on August 2 some 375 birds, consisting mainly of 3 types of gulls, several different marsh ducks, pigeons, blackbirds, crows, and a variety of songbirds were counted on and around the beach. Dogs are prohibited from the beach, but one can still find the occasional scat sample and tracks where a few people continue to walk their dogs (probably very early or late in the day). Some of the beach was swept away by Isabel in 1993, but the sand has all been replaced.

Plans for Huntington Beach in 2006

Sampling by the VT staff will concentrate on the storm drain where the high counts and evidence of optical brighteners were found. The storm drain is downstream from the swimming area, and this has helped prevent pollution from the outfall moving into the swimming zone (no human isolates were found in the swimming areas (Tables 1 and 2). In a wetter summer, greater flow from the outfall could have an impact on the swimming area that would result in advisories. This possibility could be eliminated by determining where the high counts from the outfall are coming from and correcting those situations. Samplings in 2006 will be coordinated with the VDH staff so that additional collections can be made (by either VDH or VT staff) whenever advisories are posted in an attempt to relate advisories to certain conditions or events such as tides, storms, wind direction, and bird patterns. This may help explain the origins of the high *Enterococcus* counts that might result in sporadic advisories at this beach.

1. E. Yorktown Beach

Yorktown Beach is a small beach located on the south bank of the York River immediately southeast of the George P. Coleman Memorial Bridge. The beach consists of two adjacent swimming areas, separated by sand and retained by a small break-wall, and with the easternmost pool enclosed by buoys. The Peninsula Health District monitors this beach and samples weekly at two locations, one in each swimming area.

Yorktown Beach had no swimming advisories in either 2004 or 2005 and contains no visible storm drains in or around the beach area. The appearance of this beach is very clean, and the Village of Yorktown provides a high level of maintenance at this beach. The beach is popular and is routinely used by swimmers. No dog wastes were ever observed on this beach. In addition to the weekly VDH monitoring, Dr. Hagedorn collected three sets of samples from this beach on consecutive days in late August, 2006, when he was using Dr. Kator's lab at VIMS to do the cross-validation tests with the labs used by VDH for monitoring purposes. Yorktown A was taken at the VDH sampling site in the western swimming area and Yorktown B was collected at the VDH sampling site in the eastern swimming area. All monitoring results were well below the regulatory standard (Table 1), and source tracking results from the three samplings in August showed a dominant bird and a smaller wildlife signature at both locations. No isolates from dogs or humans were detected, and fluorometry readings for optical brighteners (OB) were all negative (below 100), indicating that the water at this beach was in good condition when the samples were collected in August (see images on following page).

Table 1. Monitoring and source tracking results for Yorktown Beach.

Date	Beach/Location	Bird	Human	Pet	Wildlife	Total	cfu/100ml	OB (mg/l)
08/06 Day 1	Yorktown A	6	0	0	0	6	6	26.3
	Yorktown B	7	0	0	3	10	10	41.0
08/06 Day 2	Yorktown A	9	0	0	3	12	14	32.7
	Yorktown B	8	0	0	4	12	12	30.4
08/06 Day 3	Yorktown A	10	0	0	2	12	17	27.6
	Yorktown B	9	0	0	3	12	21	31.2

Plans for Yorktown Beach in 2006

Yorktown seems to have few problems with water pollution, and no visible means by which bacteria could be transported in large numbers into the swimming areas from locations off the beachfront. Minimal monitoring of Yorktown, in coordination with VDH staff, will be needed in 2006.

Image 1. The western swimming area at Yorktown Beach.

Image 2. The eastern swimming area at Yorktown Beach.

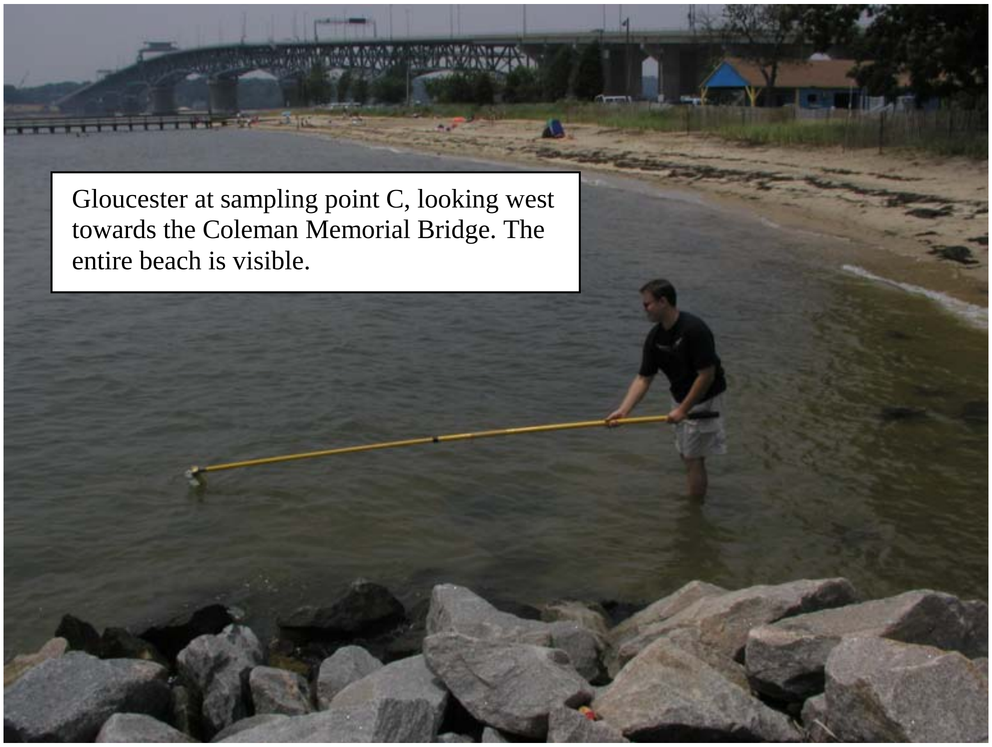
2. Three Rivers Health District

2. A. Gloucester Point Beach

Gloucester Point Beach is a small beach located on the north bank of the York River just east of the George P. Coleman Memorial Bridge and adjacent to the Virginia Institute of Marine Sciences (VIMS). Gloucester Point Beach is no more than 200 yards long and contains a well-maintained, lighted wooden fishing/recreation pier in the middle section of the beach (see picture below). The Three Rivers Health District monitors this beach and samples at two locations. There was one swimming advisory that lasted one day in 2004, and there were no advisories in 2005. The beach is well-maintained, trash receptacles are provided, and dogs are not permitted on the beach. This is a popular local beach and swimmers use it routinely, especially on weekends.

Fishing pier at Gloucester Point Beach.

In addition to the weekly VDH monitoring, Dr. Hagedorn collected three sets of samples from this beach on consecutive days in late August, 2006, when he was using Dr. Kator's lab at VIMS to do the cross-validations tests with the labs used by VDH for monitoring purposes. Gloucester A was taken about 50 feet to the west of the pier, within the main swimming area. Gloucester B was collected from the end of the pier, and Gloucester C was collected at the northeastern end of the swimming area along a rock barrier adjacent to VIMS property (see picture on following page). All monitoring results were well below the regulatory standard (Table 1), and source tracking results from the three samplings in August showed a dominant bird and a smaller wildlife signature at all three locations. No isolates from dogs or humans were detected, and fluorometry readings for optical brighteners (OB) were all negative (below 100), indicating that the water at this beach was in good condition when the samples were collected in August.



Gloucester at sampling point C, looking west towards the Coleman Memorial Bridge. The entire beach is visible.

No storm drains or other structures were visible anywhere along Gloucester Point to contribute to *Enterococcus* counts, and with regular trash collection, large numbers of birds did not seem to be attracted to the fishing pier.

Table 1. Monitoring and source tracking results for Gloucester Point Beach.

Date	**Beach/Location**	**Bird**	**Human**	**Pet**	**Wildlife**	**Total**	**cfu/100ml**	**OB (mg/l)**
08/06 Day 1	Gloucester A	8	0	0	4	12	12	35
	Gloucester B	7	0	0	5	12	36	51
	Gloucester C	9	0	0	3	12	27	42
08/06 Day 2	Gloucester A	10	0	0	2	12	44	34
	Gloucester B	8	0	0	4	12	62	49
	Gloucester C	7	0	0	5	12	53	45
08/06 Day 3	Gloucester A	8	0	0	4	12	40	36
	Gloucester B	9	0	0	3	12	35	57
	Gloucester C	9	0	0	3	12	27	30

Plans for Gloucester Point Beach 2006

Gloucester Point Beach appears to have few problems with enterococci in the water, and no visible means by which fecal indicator bacteria could be transported in large numbers into the swimming area from locations off the beachfront. Minimal monitoring of this beach, in coordination with VDH staff, will be needed in 2006.

3. Hampton City Department of Health

3. A. Buckroe Beach and Related Locations

The Hampton City Department of Health monitors four beach sites along the western shore of the Chesapeake Bay. Samples were collected weekly by VDH staff for the 2005 beach season from Buckroe Beach at two locations (Mid, and South), one sample is collected at North Buckroe, 1/2 mile north of Buckroe Beach, one sample is collected at Salt Ponds near the First Street entrance (roughly 1 mile north of Buckroe Beach), and one sample is collected from Grandview Pier near the Fish Tales Cafe, one mile north of Salt Ponds. The fishing piers at Buckroe Beach and Grandview Pier were wrecked by Hurricane Isabel in 2003 and were unusable in 2004. The piers had not been repaired in 2005, although there are plans to rebuild both. All of the beaches also suffered hurricane damage, but most of the planned beach restoration had been completed by the 2005 swimming season. Buckroe is heavily used by swimmers, while North Buckroe, Salt Ponds and Grandview much less so, and public access is limited to all but Buckroe Beach. There were two swimming advisories at Buckroe Beach in 2004, one at North Buckroe, and none at Salt Pond or Grandview. There were no swimming advisories in 2005 for any of the beaches.

There were two storm drains that emptied into the swimming areas at Buckroe Beach, and these were sampled regularly through manhole access by the VT staff in 2004. The drains almost always contained liquid, even when no rainfall had occurred, and samples sporadically yielded high *Enterococcus* counts and were positive for optical brighteners. It was never possible to determine exactly where the water in the drains was coming from, so city engineers improved drainage around both storm drains to reduce water seeping into the drains, both storm drains were extended over 100 yards further out into the bay, and the beach was rebuilt and another 50 to 60 yards of beach was added and extended further out. All of these improvements were completed by the 2005 swimming season, and had a positive outcome, no swimming advisories in 2005. There was rarely any water in the storm drains when samples were collected by the VT staff in 2005 from the swimming areas and the drains were inspected.

Samples were collected regularly over the summer of 2005 at Buckroe Beach by VT staff at three locations; sampling site A was 100 yards south of the condemned pier (where one of the storm drains had been extended), sampling site B was adjacent to the condemned pier (on the south side), and sampling site C was 100 yards north of the condemned pier, where the second storm drain had been extended. All samples were collected approximately 20 to 30 yards from the beach, where the water was knee to waist deep. For the three tables on the following pages, sample A was collected the first week of each month, April thru September, and sample B was collected the third week of each month. For all three sampling sites there were no counts that exceeded the standard, and all optical brightener readings were negative (Table 1-3). Samples were collected frequently enough so that a variety of tidal conditions were encountered, and there was no relationship between the tide and the *Enterococcus* counts. The extension of the beach created what is essentially a very large sand filter. The sand at a beach can serve as a filter and remove many of the pollutants and bacteria that would otherwise find their way into the water. Since large numbers of shore birds and nuisance birds (pigeons) were frequently seen on or near the beach, and there were no advisories in 2005, the beach is clearly having a positive impact in serving as a sand filter, even though that was not the intention of the rebuilding efforts. The other beaches were not sampled on a regular basis because they are seldom used for swimming and there had only been one swimming advisory (North Buckroe) in 2004.

Table 1. Monitoring data for Buckroe Beach, site A.

Collection Date	Location*	Optical Brighteners	Tidal Level	cfu/100ml (Ent)
0405A**	Buckroe A	35.0	Low-in	25
0405B	Buckroe A	48.3	Low-in	19
0505A	Buckroe A	56.5	Low-out	34
0505B	Buckroe A	32.2	Low-out	52
0605A	Buckroe A	44.6	High-in	48
0605B	Buckroe A	37.3	Low-out	31
0705A	Buckroe A	25.8	Mid-out	43
0705B	Buckroe A	30.3	High-out	31
0805A	Buckroe A	24.2	High-out	28
0805B	Buckroe A	33.0	High	32
0905A	Buckroe A	28.3	Low-out	40
0905B	Buckroe A	25.1	High -in	21

*Buckroe A collected 100 yards south of the pier.
**A collected 1st week and B collected 3rd week of each month.

Table 2. Monitoring data for Buckroe Beach, site B.

Collection Date	Location*	Optical Brightener	Tidal Level	cfu/100ml (Ent)
0405A**	Buckroe B	25.7	Low-in	23
0405B	Buckroe B	24.7	Low-in	10
0505A	Buckroe B	32.1	Low-out	28
0505B	Buckroe B	45.6	Low-out	30
0605A	Buckroe B	36.2	High-in	29
0605B	Buckroe B	28.4	Low-out	44
0705A	Buckroe B	30.7	Mid-out	35
0705B	Buckroe B	42.6	High-out	28
0805A	Buckroe B	40.5	High-out	27
0805B	Buckroe B	28.3	High	12
0905A	Buckroe B	41.6	Low-out	27
0905B	Buckroe B	33.2	High -in	25

*Buckroe B collected adjacent to the pier, on the south side.
**A collected 1st week and B collected 3rd week of each month.

Table 3. Monitoring data for Buckroe Beach, site C.

Collection Date	Location*	Optical Brightener	Tidal Level	cfu/100ml (Ent)
0405A**	Buckroe C	43.5	Low-in	15
0405B	Buckroe C	54.3	Low-in	22
0505A	Buckroe C	46.5	Low-out	47
0505B	Buckroe C	39.3	Low-out	41
0605A	Buckroe C	35.6	High-in	20
0605B	Buckroe C	43.4	Low-out	36
0705A	Buckroe C	52.7	Mid-out	34
0705B	Buckroe C	35.4	High-out	47
0805A	Buckroe C	26.8	High-out	33
0805B	Buckroe C	39.1	High	22
0905A	Buckroe C	23.0	Low-out	35
0905B	Buckroe C	22.2	High -in	29

*Buckroe C collected 100 yards north of the pier.
**A collected 1st week and B collected 3rd week of each month.

Microbial Source Tracking (MST) results showed birds as the dominant signature (80.7%), with some minor contribution from pets (1.4%) and wildlife (17.9%, Table 4). The 12 biweekly samplings were combined for each of the three sites since the results were nearly the same for all samples. No human-origin isolates were detected from any of the samples and it appears that alterations to the storm drain system and rebuilding plus extending the beach have eliminated the human-origin pollution that was detected on occasion in 2004. There is now an area at Buckroe Beach set aside for exercising and walking dogs, and the absence of advisories in 2005 indicates that the beach replenishment and drainage changes that were made prior to the 2005 swimming season were effective.

Table 4. Source tracking results for Buckroe Beach, all dates combined.

Date	Beach/Location	Bird	Human	Pet	Wildlife	Total
2005	Buckroe A	217	0	2	69	288
2005	Buckroe B	244	0	7	37	288
2005	Buckroe C	236	0	3	49	288
2005	Totals	679	0	12	155	864
2005	Percentages	80.7	0	1.4	17.9	100

The images on the following three pages illustrate the current conditions at Buckroe Beach. On the following page, image 1 shows the condemned pier in 2005 and image 2 shows the pier in 2004. By comparing the two images, the size of the beach extension can readily be seen as much of the pier in image 1 is now over sand instead of water. Plans are underway to rebuild the pier, but construction was halted in 2005 by the discovery of nesting shorebirds that were identified as endangered (image 4). Officials plan on having the pier rebuilt and open for the 2006 swimming season. A “Bark Park” (image 3) was added in 2005 as a place to walk and exercise dogs and to encourage pet owners to not take their pets on the beach. Receptacles for pet wastes are provided at the park.

Image 1. Rebuilt and extended beach, and condemned pier, in 2005.

Image 2. Beach and condemned pier in 2004.

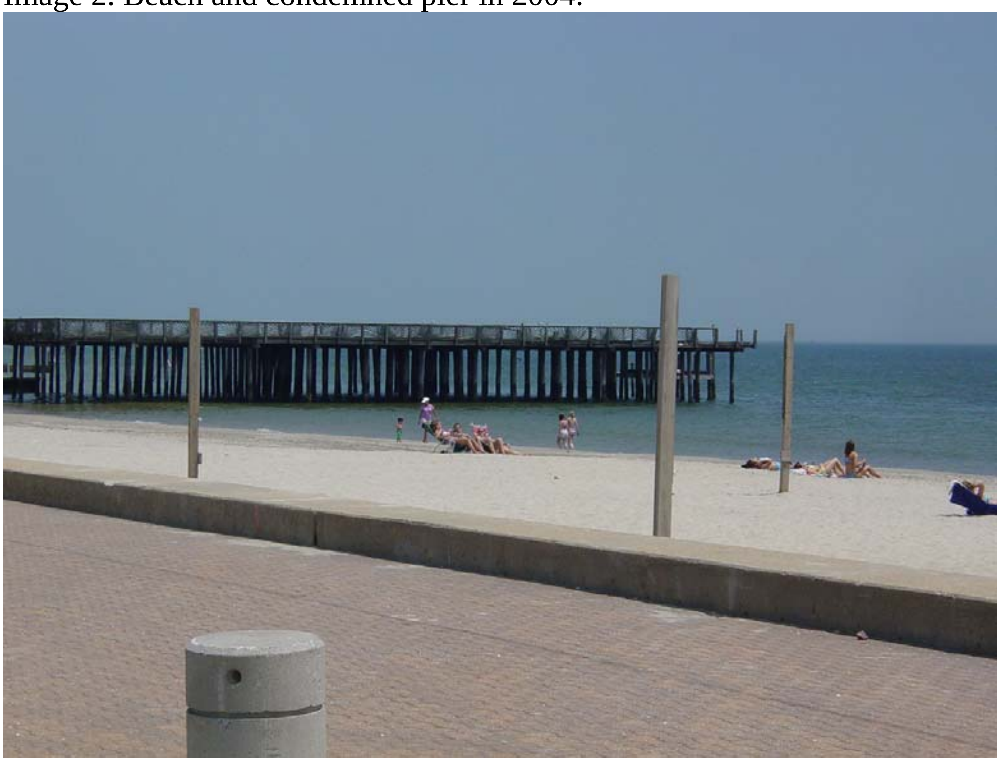


Image 3. Area provided for walking and exercising dogs.

Image 4. Nesting birds halted reconstruction of the pier in summer of 2005.

Image 5. Birds on the beach, early morning, August 2005.

The above image shows the large numbers of shore and nuisance birds (pigeons) that appear to permanently reside in the area and are often seen on the beach when few people are around. The lack of swimming advisories demonstrates the effectiveness of the rebuilt beach in acting as a sand filter and removing microorganisms that might otherwise end up in the water.

Plans for Buckroe and Related Beaches in 2006

There is little need to continue regular sample collections by the VT staff at North Buckroe, Salt Ponds, or Grandview. While the public is not prohibited from using these beaches, there is no public parking and no signs identifying public access. It is debatable as to whether or not these are truly public beaches. With the changes made to Buckroe Beach in 2005, it is anticipated that further advisories are unlikely. The only possibilities are the potential attraction of shore birds to the pier, but there are already large flocks of birds in the area and these were not problematic in 2005. Periodic sampling by the VT staff around both the pier and the locations where the storm drains were extended is reasonable in 2006 to further confirm the success of the beach replenishment projects that were done in 2005. Such monitoring could be important if the summer of 2006 is wetter than the past two summers. Sampling will be coordinated with the VDH staff so that additional collections can be made (by either VDH or VT staff) in a “quick response” mode whenever advisories are posted in an attempt to relate advisories to certain conditions or events such as tides, storms, wind direction, and bird patterns. This should help explain the origins of any high *Enterococcus* counts that may result in sporadic advisories at this beach.

4. Norfolk Department of Health

4. A. Norfolk Beaches

Norfolk beaches encompass a five-mile stretch along the southern side of the Chesapeake Bay between the Norfolk Naval Station and US Navy Little Creek Amphibious Base. The Norfolk Health Department monitored nine locations weekly during the 2004 and 2005 beach seasons. There were two swimming advisories in 2004, and none in 2005. The Norfolk beaches were heavily damaged, and two piers were destroyed, by Hurricane Isabel in 2003. Major beach restoration efforts were underway throughout the summer of 2004 that included dredging sand to increase the width of the beaches, installing breakwaters to reduce beach erosion, and repairing or constructing jetties to further protect the beaches. Appropriate vegetation was planted on the upper portions of several beaches to stabilize the sand and protect sand dunes, and a very large pier was under construction during the summer of 2005. The Norfolk beaches are also the recipient of fortunate geography. The main currents that move in and out of the lower bay and the ocean with tidal changes run along the Norfolk coast. These currents will tend to quickly disperse and dilute any pollutants in the swimming areas and, along with the beach restorations, should result in very infrequent swimming advisories. The success of the beach improvements was apparent in 2005. There are numerous storm drain outfalls on many of the Norfolk beaches, and samples collected in 2004 from these outfalls produced *Enterococcus* counts well above state standards. Even though most of the outfalls empty directly into swimming areas, only 11 (8.1%) of the 135 weekly samples collected by the VDH staff from the Norfolk beaches in 2005 produced *Enterococcus* counts above 10 cfu/100mL (and the highest count recorded for the summer was just 85 cfu/100mL). These results demonstrate the positive impact of beach replenishment in combination with active currents that move water away from the beaches.

In 2005 the VT staff concentrated on collecting samples (twice a month for six months, April through September) at specific VDH sampling locations to examine the impact of beach restoration efforts on water quality. One of the sampling sites (VDH-N9) included the storm drain outfalls that produced the highest *Enterococcus* counts in 2004. The sites used by the VT staff in 2005 were:

VDH-N4, at 21st Bay Street, one sampling site, samples collected at the westernmost jetty to assess the impact of beach improvements.

VDH-N9, at Ocean View Park, the most popular of the Norfolk beaches. Four sampling sites:
- N9 – east end of the beach, left side of the main jetty
- SW-E at N-9, east end of the beach, right side of the double storm drain
- SW-W at N-9, east end of the beach, left side of double storm drain
- SW2 at N-9, west end of the beach, right side of the storm drain

VDH-N12, at 13th Street, one sampling site, samples collected west of the main jetty at this location.

For the twelve tables on the following four pages (monitoring and source tracking results for each of the above six sampling sites), the date followed by an “A” (for example, 0405A) indicates that the sample was collected the first week of each month, April thru September, and the date followed by a “B” indicates the sample was collected the third week of each month. Source tracking was performed on just the samples with the highest counts. A discussion of the results is on the page following the twelve tables, then there are four pictures of the Norfolk beaches on two pages after the discussion, and the plans for the Norfolk beaches in 2006 are on the last page after the pictures.

Table 1. Monitoring results for Norfolk 4.

Collection Date	Location	OB	Tidal Level	Cfu/100ml
0405A*	Norfolk 4	26.3	High-in	34
0405B	Norfolk 4	19.4	Low-in	28
0505A	Norfolk 4	25.8	Low-in	**250**
0505B	Norfolk 4	15.4	Mid-in	16
0605A	Norfolk 4	24.3	High-out	18
0605B	Norfolk 4	18.5	Low-out	60
0705A	Norfolk 4	16.0	Low-in	5
0705B	Norfolk 4	18.4	Low-out	31
0805A	Norfolk 4	27.2	High-out	27
0805B	Norfolk 4	26.8	High	1
0905A	Norfolk 4	19.6	Low-in	51
0905B	Norfolk 4	16.6	High-in	20

*Sample A collected 1st week and sample B collected 3rd week of each month.

Table 2. Microbial source tracking results for Norfolk 4.

Collection Date	Location	Bird	Human	Pets	Wildlife	Total
0505A	Norfolk 4	14	0	0	2	16
0605B	Norfolk 4	10	0	0	6	16
0705B	Norfolk 4	12	0	2	2	16
0805A	Norfolk 4	13	0	0	3	16
0905A	Norfolk 4	10	0	1	5	16
0905B	Norfolk 4	11	0	1	4	16
Total	Norfolk 4	**70**	**0**	**4**	**22**	**96**
%		***72.9***	***0.0***	***4.2***	***22.9***	**100**

Table 3. Monitoring results for Norfolk 9 SW-E.

Collection Date	Location	OB	Tidal Level	cfu/100ml
0405A*	Norfolk 9 SW-E	-	High-in	-
0405B	Norfolk 9 SW-E	22.8	Low-in	40
0505A	Norfolk 9 SW-E	-	Mid-in	-
0505B	Norfolk 9 SW-E	-	High-out	-
0605A	Norfolk 9 SW-E	64.3	Low-out	**185**
0605B	Norfolk 9 SW-E	**110.0**	**Low-in**	**2,460**
0705A	Norfolk 9 SW-E	95.7	Mid-out	100
0705B	Norfolk 9 SW-E	80.3	High-out	**700**
0805A	Norfolk 9 SW-E	-	High	-
0805B	Norfolk 9 SW-E	21.2	High-in	0
0905A	Norfolk 9 SW-E	-	Low-in	-
0905B	Norfolk 9 SW-E	-	High-in	-

*Sample A collected 1st week and sample B collected 3rd week of each month.

Table 4. Microbial source tracking results for Norfolk 9 SW-E.

Collection Date	Location	Bird	Human	Pets	Wildlife	Total
0405B	Norfolk 9 SW-E	12	0	1	3	16
0605A	Norfolk 9 SW-E	9	0	2	5	16
0605B	Norfolk 9 SW-E	10	0	2	4	16
0705A	Norfolk 9 SW-E	11	0	1	4	16
0705B	Norfolk 9 SW-E	12	0	2	2	16
Total	Norfolk 9 SW-E	**54**	**0**	**8**	**18**	**80**
%		***67.5***	***0.0***	***10.0***	***22.5***	**100**

Table 5. Monitoring results for Norfolk 9.

Collection Date	Location	OB	Tidal Level	cfu/100ml
0405A*	Norfolk 9	32.4	High-out	20
0405B	Norfolk 9	22.7	High-in	5
0505A	Norfolk 9	26.2	Low-in	4
0505B	Norfolk 9	19.6	Mid-in	100
0605A	Norfolk 9	22.5	High-out	3
0605B	Norfolk 9	25.8	Low-out	40
0705A	Norfolk 9	15.5	Low-in	7
0705B	Norfolk 9	18.1	Mid-out	23
0805A	Norfolk 9	24.7	High-out	36
0805B	Norfolk 9	19.7	High	16
0905A	Norfolk 9	19.9	Low-in	25
0905B	Norfolk 9	18.9	High-in	37

*Sample A collected 1st week and sample B collected 3rd week of each month.

Table 6. Microbial source tracking results for Norfolk 9.

Collection Date	Location	Bird	Human	Pets	Wildlife	Total
0405A	Norfolk 9	12	0	0	4	16
0505B	Norfolk 9	14	0	1	1	16
0605B	Norfolk 9	13	0	1	2	16
0705B	Norfolk 9	15	0	0	1	16
0805A	Norfolk 9	13	0	1	3	16
0805B	Norfolk 9	14	0	0	2	16
0905A	Norfolk 9	12	0	1	3	16
0905B	Norfolk 9	15	0	1	0	16
Total	Norfolk 9	**107**	**0**	**5**	**16**	**128**
%		***83.6***	***0.0***	***3.9***	***12.5***	**100**

Table 7. Monitoring results for Norfolk 9 SW2.

Collection Date	Location	OB	Tidal Level	cfu/100ml
0405A*	Norfolk 9 SW2	-	High-out	-
0405B	Norfolk 9 SW2	-	High-in	-
0505A	Norfolk 9 SW2	**801**	**Low-in**	**1,150**
0505B	Norfolk 9 SW2	**407**	**Mid-in**	**990**
0605A	Norfolk 9 SW2	**518**	**High-out**	**5,960**
0605B	Norfolk 9 SW2	**233**	**Low-out**	5
0705A	Norfolk 9 SW2	**493**	**Low-in**	**1,840**
0705B	Norfolk 9 SW2	-	Mid-out	-
0805A	Norfolk 9 SW2	**>999**	**High-out**	**15,700**
0805B	Norfolk 9 SW2	19.1	High	30
0905A	Norfolk 9 SW2	**174**	**Low-in**	**550**
0905B	Norfolk 9 SW2	-	High-in	-

*Sample A collected 1st week and sample B collected 3rd week of each month.

Table 8. Microbial source tracking results for Norfolk 9 SW2.

Collection Date	Location	Bird	Human	Pets	Wildlife	Total
0505A	Norfolk 9 SW2	6	5	1	4	16
0505B	Norfolk 9 SW2	6	5	3	2	16
0605A	Norfolk 9 SW2	5	4	5	2	16
0705A	Norfolk 9 SW2	6	4	3	3	16
0805A	Norfolk 9 SW2	6	5	2	3	16
0905A	Norfolk 9 SW2	7	4	3	2	16
Total	Norfolk 9 SW2	**36**	**27**	**17**	**16**	**96**
%		***37.5***	***28.2***	***17.7***	***16.6***	**100**

Table 9. Monitoring results for Norfolk 9 SW-W.

Collection Date	Location	OB	Tidal Level	cfu/100ml
0405A*	Norfolk 9 SW-W	-	High-out	-
0405B	Norfolk 9 SW-W	-	High-in	-
0505A	Norfolk 9 SW-W	-	Low-in	-
0505B	Norfolk 9 SW-W	-	Mid-in	-
0605A	Norfolk 9 SW-W	-	High-out	-
0605B	Norfolk 9 SW-W	30.3	Low-out	**2,740**
0705A	Norfolk 9 SW-W	-	Low-in	-
0705B	Norfolk 9 SW-w	-	Mid-out	-
0805A	Norfolk 9 SW-W	-	High-out	-
0805B	Norfolk 9 SW-w	18.5	High	20
0905A	Norfolk 9 SW-W	-	Low-in	-
0905B	Norfolk 9 SW-W	-	High-in	-

*Sample A collected 1st week and sample B collected 3rd week of each month.

Table 10. Microbial source tracking results for Norfolk 9 SW-W.

Collection Date	Location	Bird	Human	Pets	Wildlife	Total
0605B	Norfolk 9 SW-W	9	0	2	5	16
0805B	Norfolk 9 SW-W	13	0	0	3	16
Total	Norfolk 9 SW-W	**22**	**0**	**2**	**8**	**32**
%		***68.8***	***0.0***	***6.2***	***25.0***	**100**

Table 11. Monitoring results for Norfolk 12.

Collection Date	Location	OB	Tidal Level	cfu/100ml
0405A*	Norfolk 12	29.4	High-out	4
0405B	Norfolk 12	23.8	High/Mid-	5
0505A	Norfolk 12	29.9	Low-in	**240**
0505B	Norfolk 12	18.9	Mid-in	62
0605A	Norfolk 12	27.6	High-out	3
0605B	Norfolk 12	18.6	Low-out	37
0705A	Norfolk 12	20.7	Low-in	31
0705B	Norfolk 12	18.6	Mid-out	14
0805A	Norfolk 12	25.2	High-out	23
0805B	Norfolk 12	19.6	High	6
0905A	Norfolk 12	19.0	Low-in	56
0905B	Norfolk 12	18.6	High-in	5

*Sample A collected 1st week and sample B collected 3rd week of each month.

Table 12. Microbial source tracking results for Norfolk 12.

Collection Date	Location	Bird	Human	Pets	Wildlife	Total
0505A	Norfolk 12	15	0	0	1	16
0505B	Norfolk 12	6	0	1	1	16
0605B	Norfolk 12	9	0	2	5	16
0705A	Norfolk 12	14	0	0	2	16
0805A	Norfolk 12	13	0	0	3	16
0905A	Norfolk 12	8	0	0	0	16
Total	Norfolk 12	**81**	**0**	**3**	**12**	**96**
%		***84.4***	***0.0***	***3.1***	***12.5***	**100**

For Norfolk 4 (21st Bay Street at the westernmost jetty) there was one sample that exceeded the standard (May, Table 1), and the major sources of the *Enterococcus* isolates were birds (72.9% of the total, Table 2), with wildlife and dogs as secondary sources (22.9% and 4.2%, respectively, Table 2). No isolates were classified as human in origin. For Norfolk 9 SW-E (right side of double storm drain, east end of Ocean View Beach), there were three samples that exceeded the standard (two in June and one in July, Table 3), and the major sources of the *Enterococcus* isolates were birds (67.5% of the total, Table 4), with wildlife and dogs as secondary sources (22.5% and 10.0%, respectively, Table 4). No isolates were classified as human in origin. One sample, 0605B, had high counts (2,460 cfu/100mL, bold in Table 3) and was positive for optical brighteners. For Norfolk 9 (jetty at east end of Ocean View Beach) there were no samples that exceeded the standard (Table 5), and the major sources of the *Enterococcus* isolates were birds (83.6% of the total, Table 6), with wildlife and dogs as secondary sources (12.5% and 3.9%, respectively, Table 6). No isolates were classified as human in origin. For Norfolk 9 SW2 (storm drain outfall on western end of the Ocean View Beach), there were six of eight samples that exceeded the standard (Table 7), and the major sources of the *Enterococcus* isolates were birds (37.5% of the total, Table 8), with humans, dogs, and wildlife as secondary sources (28.2%, 17.7%, and 16.6%, respectively, Table 8). Twenty seven isolates were classified as human in origin, and were nearly equally divided over the six samples where source tracking was performed (Table 8). The highest counts for all of the Norfolk samples were recorded at this location, and four of the six samples yielded counts over 1,000 (the four counts ranged from 1,150 cfu/100mL to 15,700 cfu/100mL, bold, Table 7). The optical brightener readings were positive (over 100, some were very high, bold in Table 7) for all samples except one. Based on observations over the summer, a laundromat located near the beach on Ocean View Avenue appears to be connected to this storm drain. This would explain the very high optical brightener readings and the *Enterococcus* counts (laundering of diapers, for example). This possible laundry cross-connection with a storm drain has been reported to authorities.

For Norfolk 9 SW-W (left side of double storm drain, east end of Ocean View Beach), only two samples were collected (usually there was no flow from this drain) and one of them exceeded the standard (June, Table 9), and the major sources of the *Enterococcus* isolates for the two samples were birds (68.8% of the total, Table 10), with wildlife and dogs as secondary sources (25.0% and 6.2%, respectively, Table 10). No isolates were classified as human in origin. For Norfolk 12 (13th Street, west of the main jetty) there was just one sample that exceeded the standard (May, Table 11), and the major sources of the *Enterococcus* isolates were birds (84.4% of the total, Table 12), with wildlife and dogs as secondary sources (12.5% and 3.1%, respectively, Table12). No isolates were classified as human in origin.

In summary, the Norfolk beaches were in good condition in 2005 and no swimming advisories were posted. Most of the beach replenishment projects had been completed by the 2005 swimming season, and the storm drains that the VT staff monitored in 2005, with the exception of Norfolk 9 SW2, did not produce large numbers of enterococci. Clearly the drain at SW2 is in need of attention, as a laundry appears to be connected to it, and the large numbers of enterococci that were obtained from samples of this storm drain could impact the swimming areas of Ocean View Beach in a wetter summer. Other than this storm drain, there is little else apparent on the Norfolk beaches that might be expected to cause swimming advisories.

Image 1. Jay Dickerson sampling at 21st Bay Street, (Norfolk 4).

Image 2. Charles Hagedorn sampling the storm drain outfall at low tide further east of Ocean View Park.

Image 3. Ocean View Park (Norfolk 9), looking west, with the new fishing pier under construction in the background.

Image 4. New fishing pier under construction west of Ocean View Park (Norfolk 9).

Plans for Norfolk Beaches in 2006

The Norfolk beaches essentially started with a “clean slate” in 2005 as a result of the beach restoration efforts necessitated by Hurricane Isabel in 2003. The most visible potential sources of water pollution in 2004, as the restoration projects were underway, were birds and storm drains. People were observed walking dogs on the beach in 2004 and 2005, but individuals were also observed picking up dog wastes, so an effective education program about beach litter seems to be in place in Norfolk. Although source tracking indicated that a small percentage of the *Enterococcus* isolates at most locations were from dogs in 2005 (see all even numbered tables), these did not result in advisories (but there is still room for improvement to further reduce contamination from dogs). The major items that will be monitored by the VT staff in 2006 are the storm drain at Norfolk 9 SW2 (possible cross-connection), and the new fishing pier. Both of these will be examined with regard to possible impacts on the swimming areas at Ocean View Beach (the most popular and heavily used of the Norfolk beaches). The SW2 storm drain could pollute the swimming areas in a wetter summer (or with heavier use of the laundry) and the fishing pier could attract large numbers of birds and possibly alter the currents that move along Ocean View, causing contaminants to be held closer to shore where the VDH monitoring might detect them, resulting in swimming advisories. Samplings will be coordinated with the VDH staff so that additional collections can be made (by either VDH or VT staff) in a “quick response” mode whenever advisories are posted in an attempt to relate advisories to storm drains, or birds (or some combination of these).

5. Virginia Beach Department of Public Health

5. A. Virginia Beach and Associated Bay Beaches

The Virginia Beach Department of Health monitors both oceanfront and bayside beaches in a section stretching from the Chesapeake Bay Bridge Tunnel, then east to Cape Henry, then south to Back Bay Beach (some 28 miles of shoreline). Twenty-four samples were collected offshore weekly from a police boat during 2004 and there were no swimming advisories that summer. In 2005 the sampling arrangements were changed and the weekly samples were collected in the surf, a much preferable approach. There was only one swimming advisory in 2005 and the single advisory (between 45th and 63rd streets in August) was apparently due to a pumping problem in a sewer line rather than from any type of persistent fecal pollution. Due to a lab error, no samples from the advisory were sent to VT for source tracking. MST was performed on one complete set of Virginia Beach samples collected in July, 2005, and *Enterococcus* isolates were not abundant at any locations (Table 1). Optical brighteners (OB) were not detected at elevated levels in any of the samples, confirming the absence of pollution from human sources. Most of the *Enterococcus* isolates were from birds (77.5%, Table 1). There were a few isolates from dogs, mainly on the bayside beaches. The bayside beaches suffered some minor hurricane damage in 2003 but had been fully restored by the 2005 swimming season. The ocean beaches are the most popular in Virginia, the bayside beaches considerably less so.

Table 1. Results for samples collected at Virginia Beach in July, 2005.

Beach/Location	cfu/100mL	No. for MST	Birds	Pets	Humans	Wildlife	OB (mg/l)
1. Back Bay Beach	19	10	9	0	0	1	42.6
2. Little Island South	24	10	7	0	0	3	24.5
3. Little Island North	11	10	7	0	0	3	40.7
4. Sandbridge South	7	7	8	0	0	2	43.3
5. Sandbridge North	9	9	7	0	0	3	41.6
6. Dam Neck South	18	10	8	0	0	2	41.8
7. Dam Neck Mid	7	7	6	0	0	4	40.2
8. Dam Neck North	13	10	7	0	0	3	38.4
9. Camp Pendelton	20	10	10	0	0	0	29.2
10. Croatoan	18	10	9	0	0	1	37.2
11. 15th St.	12	10	10	0	0	0	20.5
12. 28th St.	9	9	10	0	0	0	30.3
13. 45th St.	12	10	10	0	0	0	27.1
14. 63rd St.	11	10	9	0	0	1	38.1
15. 78th St.	10	10	8	2	0	2	47.6
16. Fort Story South	10	10	10	0	0	0	34.8
17. Cape Henry	21	10	8	0	0	2	25.4
18. Fort Story East	16	10	9	0	0	1	21.3
19. Fort Story West	9	9	7	0	0	3	42.0
20. First Landing Park	11	10	9	1	0	1	31.4
21. Sea Gate	19	10	10	3	0	0	21.7
22. Lesner Bridge East	14	10	7	2	0	3	20.6
23. Chesapeake Beach	20	10	8	4	0	2	36.8
24. Chick's Beach	31	10	9	2	0	1	28.4
Totals	351	231	179 (77.5%)	14 (6.1%)	0 (0.0%)	38 (16.4%)	

The following three images show the bayside and two areas along Virginia Beach where samples are collected.

Image 1. Bayside collection site, near First Landing Park.

Image 2. North Virginia Beach, near 78^{th} Street.

Image 3. South Virginia Beach, near Little Island Beach.

Plans for Virginia Beach in 2006

With the tides and currents along both the open ocean and the bayside, swimming advisories should not be a problem at these beaches and regular sampling by the VT staff is no longer necessary. Communications will be maintained with the VDH staff so that additional sample collections can be made (by either VDH or VT staff) in a "quick response" mode whenever advisories are posted in an attempt to relate advisories to certain conditions or events such as tides, storms, wind direction, and bird patterns. This should help explain the origins of high *Enterococcus* counts that may result in sporadic advisories at any of the Virginia Beach locations.

6. Rappahannock Health District

6. A. Fairview Beach

Fairvew Beach is located on the southern bank of the Potomac River, northeast of Fredericksburg. The Rappahannock Health District monitors 4 sites weekly across the length of the beach (roughly 1½ miles of shoreline) during the swimming season (the designated swimming areas are much smaller). Fairview Beach posted four swimming advisories during the summer of 2004 and three advisories in 2005. Fairview Beach sustained heavy damage from Hurricane Isabel in 2003 and, to date, very little beach restoration has been accomplished. The beach is popular in the summer, especially on weekends. Fairview Beach is not in good condition. An additional ten to fifteen yards of beach is needed, at a minimum, as over half of the remaining beach is submerged at high tide. Trash on the beach does not appear to be much of a problem, but dogs are not restricted and pet wastes were observed near the beach on sampling trips in 2004 and 2005. The area surrounding the beach also needs improvement in drainage control so that precipitation does not flow down the steep bluffs adjacent to the beach and then directly into the swimming areas. Finally, breakwater structures need to be built or repaired to control beach erosion from tides and storms. Without such improvements, periodic swimming advisories should be expected in the future, especially in wet summers.

In 2005, samples from Fairview Beach collected by VDH staff were taken to the DSS-VDH lab in White Stone, VA, where membrane-filtration was performed to obtain the *Enterococcus* counts on the weekly samples. All filtration plates that contained sufficient colonies for source tracking to be performed were sent to the VT lab in July and August, including those plates where the counts exceeded the standard and a swimming advisory was posted. Additional samples were taken in June, 2005, by the VT staff from sites around the regular sampling locations. In 2004 a sinkhole located at 8th Street was found and sampled. A strong human signature was obtained from the source tracking results and fluorescent compounds were detected that were consistently double the concentration found in the open waters of the Potomac River, consistent with the human isolates detected by source tracking. The 8th St. sinkhole was filled in with concrete at the end of 2004. The June 15 samplings (Table 1) concentrated on the 8th Street area to see if the human-origin pollution was still present.

Table 1. Analysis of Fairview Beach samples collected 6/15/05.

Count Col %	FV201 - Fairview #4	FV201 - Fairview #5	FV201 - Fairview #6	FV201 - Fairview #7
Bird	1 6.25	1 6.25	8 50.00	18 90.00
Human	1 6.25	0 0.00	0 0.00	0 0.00
Pets	9 56.25	5 31.25	2 12.50	0 0.00
Wildlife	5 31.25	10 62.50	6 37.50	2 10.00
Totals	16	16	16	20
cfu/100mL	29	73	220	670
OBs	30.1	34.8	32.4	37.8

Site locations: No. 4, regular VDH sampling location; No. 5, storm drain immediately to the west of the Maryland restaurant; No. 6, water column at the end of the 8th Street storm drain; No. 7, inside the storm drain at 8th Street. Fairview sites 1, 2, and 3 were also sampled (these are the regular VDH sites), plus a site labeled FV#8, taken from the end of the pier adjacent to the 8th Street storm drain. The *Enterococcus* counts for these four samples were all below 10 cfu/100mL, so source tracking was not performed on them. The optical brightener (OB) results were all negative (below 100), indicating a lack of pollution from human sources. The major contributors for the June 15 samples (Table 1) were birds, dogs, and wildlife, all indicative of contamination caused by runoff from adjacent land. Most (if not all) of this could be eliminated by replenishing the beaches and controlling dogs. No human signatures were found except for one isolate in sample No. 4. This is not a serious issue as occasional human isolates from swimming/wading beach areas should be expected. Clearly there is an *Enterococcus* load entering the water from the storm drain (sites 6 and 7, Table 1), but the human-origin pollution that was seen in 2004 was not present in these June 15, 2005, samples.

The filtration plates for samples collected from 6/15/05 to 7/6/05 (and the remaining sample water) were sent to VT for source tracking. Samples 1 thru 4 were from 6/15 and described above, samples 5 thru 8 were collected on 6/22 (Table 2), samples 9 thru 12 were collected 6/29 (and the counts were very low, so source tracking was not performed on them), and samples 13 thru 16 were collected on 7/6/05 (Table 3).

Table 2. Analysis of Fairview Beach samples collected 6/22/05.

Count Col %	FV202 - FV#5 (#1)	FV202 - FV#6 (#2)	FV202 - FV#7 (#3)	FV202 - FV#8 (#4)
Bird	2 12.50	18 94.74	6 42.86	7 50.00
Human	0 0.00	0 0.00	1 7.14	0 0.00
Pets	13 81.25	0 0.00	4 28.57	2 14.29
Wildlife	1 6.25	1 5.26	3 21.43	5 35.71
Totals	16	19	14	14
cfu/100mL	177	181	22	14
OBs	35.6	40.5	32.6	38.0

Table 3. Analysis of Fairview Beach samples collected 7/6/05 (resample issued).

Count Col %	FV202 - FV#13	FV202 - FV#14	FV202 - FV#15	FV202 - FV#16
Bird	9 56.25	8 44.44	12 60.00	20 83.33
Human	0 0.00	0 0.00	0 0.00	1 4.17
Pets	3 18.75	2 11.11	4 20.00	2 8.33
Wildlife	4 25.00	8 44.44	4 20.00	1 4.17
Totals	16	18	20	24
cfu/100mL	161	177	170	182
OBs	41.6	33.4	36.7	32.5

The optical brightener results were all negative (below 100) for the samples in Tables 2 and 3, indicating a lack of pollution from human sources. The major contributors for these samples were birds, dogs, and wildlife (as in Table 1), all indicative of contamination caused by runoff from adjacent land. Only two isolates were classified as from human origin, one in sample 7 (Table 2) and one in sample 16 (Table 3). While the absence of isolates of human origin is encouraging, the persistent pollution from dogs in all three tables indicates problems with pet owners and waste collection. The next set of plates sent to the VT lab covered the rest of the swimming season, from 7/20/05 to 8/30/05. Counts from samples 17 thru 20 (7/11/05) were all low so source tracking was not performed on them. Due to high counts, advisories were posted on 7/20/05 (samples 21 thru 24, Table 4) and on 7/22/05 (samples 25 thru 28, Table 5). Samples 29 thru 32 (7/26/05) were below the regulatory standard but still sufficiently high for source tracking to be performed (Table 6). Source tracking was not performed on the samples from 8/2/05, 8/9/05, and 8/16/05 (samples 33-44) due to low counts.

Table 4. Analysis of Fairview Beach samples collected 7/20/05 (advisory issued).

Count Col %	FV203 - Fairview #21 (#1)	FV203 - Fairview #22 (#2)	FV203 - Fairview #23 (#3)	FV203 - Fairview #24 (#4)
Bird	0 0.00	10 50.00	3 21.43	2 11.76
Human	10 71.43	4 20.00	8 57.14	13 76.47
Pets	4 28.57	5 25.00	3 21.43	2 11.76
Wildlife	0 0.00	1 5.00	0 0.00	0 0.00
Totals	14	20	14	17
cfu/100mL	340	276	>104	>104
OBs	61.7	59.0	45.8	73.5

Table 5. Analysis of Fairview Beach samples collected 7/22/05 (advisory issued).

Count Col %	FV203 - Fairview #25 (#1)	FV203 - Fairview #26 (#2)	FV203 - Fairview #27 (#3)	FV203 - Fairview #28 (#4)
Bird	6 30.00	6 28.57	4 20.00	3 12.50
Human	5 25.00	5 23.81	1 5.00	3 12.50
Pets	7 35.00	1 4.76	0 0.00	0 0.00
Wildlife	2 10.00	9 42.86	15 75.00	18 75.00
Totals	20	21	20	24
cfu/100mL	128	124	88	148
OBs	66.5	59.0	87.7	53.1

Table 6. Analysis of Fairview Beach samples collected 7/26/05 (advisory lifted).

Count Col %	FV203 - Fairview #29 (#1)	FV203 - Fairview #30 (#2)	FV203 - Fairview #31 (#3)	FV203 - Fairview #32 (#4)
Bird	3 13.04	9 39.13	5 20.83	2 8.33
Human	1 4.35	6 26.09	3 12.50	2 8.33
Pets	2 8.70	1 4.35	0 0.00	1 4.17
Wildlife	17 73.91	7 30.43	16 66.67	19 79.17
Totals	23	23	24	24
cfu/100mL	46	84	44	76
OBs	52.8	46.0	48.8	48.4

Table 7. Analysis of Fairview Beach samples collected 8/23/05 (advisory posted).

Count Col %	FV203 - Fairview #45 (#1)	FV203 - Fairview #46 (#2)	FV203 - Fairview #47 (#3)	FV203 - Fairview #48 (#4)
Bird	4 20.00	3 12.50	3 13.04	9 39.13
Human	1 5.00	3 12.50	1 4.35	6 26.09
Pets	0 0.00	0 0.00	2 8.70	1 4.35
Wildlife	15 75.00	18 75.00	17 73.91	7 30.43
Totals	20	24	23	23
cfu/100mL	110	110	120	>160
OBs	87.4	68.0	73.8	64.8

Table 8. Analysis of Fairview Beach samples collected 8/26/05 (advisory lifted).

Count Col %	FV203 - Fairview #49 (#1)	FV203 - Fairview #50 (#2)	FV203 - Fairview #51 (#3)	FV203 - Fairview #52 (#4)
Bird	2 13.33	3 13.64	3 15.00	5 41.67
Human	0 0.00	2 9.09	0 0.00	0 0.00
Pets	0 0.00	0 0.00	0 0.00	0 0.00
Wildlife	13 86.67	17 77.27	17 85.00	7 58.33
Totals	15	22	20	12
cfu/100mL	44	58	52	30
OBs	47.1	47.4	61.7	53.1

The third advisory was posted on 8/23/05 (samples 45-48, Table 7). Samples 49 thru 52 (8/26/05) were below the regulatory standard but still sufficiently high for source tracking to be performed (Table 8). Source tracking was not performed on the last set of samples of the season (samples 53-56, 8/30/05) due to low counts. With the swimming advisories, human pollution was encountered again in 2005. For the first advisory (7/20/05, Table 4), 35 *Enterococcus* isolates out of 65 that source tracking was performed on were classified as human (53.8%). In addition, 14 of 65 isolates in Table 4 (21.5%) were from dogs, indicating that 75.3% of the isolates that were subjected to source tracking from the 7/20/05 samples were from dogs and humans combined (53.8% plus 21.5%). This was the highest human and dog combined pollution for the summer. When samples were taken two days later, and the swimming advisory was continued (Table 5), the numbers of isolates from humans and dogs had declined by 50%; 14 of 85 isolates (16.4%) were human and 8 of 85 isolates (9.4%) were from dogs (25.8% combined). By 7/26/05, when the advisory was lifted (Table 6), the numbers of isolates from humans and dogs continued to decline; 12 of 94 isolates (12.7%) were human and 4 of 94 isolates (4.3%) were from dogs (17.0% combined).

The third swimming advisory occurred on 8/23/05 (Table 7), and was lifted on 8/26/05 (Table 8). There were still isolates present from both humans and dogs, but both were greatly reduced from the levels seen in the July advisory samplings. For the 8/23/05 samples (Table 7), 11 of 90 isolates (12.2%) were human and 3 of 90 isolates (3.3%) were from dogs (15.5% combined). For the 8/26/05 samples (Table 8), just 2 of 69 isolates (2.9%) were human and zero of 69 isolates (0.0%) were from dogs (2.9% combined). The reduction in the numbers of isolates from humans and dogs in the August samples, as compared to the July samples, is encouraging, but the July results indicate that situations can occur at Fairview Beach where substantial pollution can be found in the swimming areas from human sources. It is not clear at this time where the human-origin pollution came from, and attempting to determine the sources of it will be a focus of research at Fairview Beach in 2006. The origin of the pollution for dogs is evident, and this can be controlled by education of pet owners and providing receptacles for dog wastes. The optical brightener readings were elevated in some of the water samples where the advisories occurred (in the 70s and 80s as compared to more typical readings in the 30s and 40s). While the elevated readings are not positive for OBs (>100 is positive), they are higher than normal and may give a clue as to the origin of the human source pollution (failing on-site systems, for example).

Plans for Fairview Beach in 2006

Based on 2004 and 2005 results, birds, dogs, wildlife and human sources are all potential contributors at Fairview Beach. The large human signature that occurred in July, 2005, is especially problematic, and efforts to determine the sources of it will be a focus of research at Fairview Beach in 2006. For any advisories that occur in 2006, source tracking will be performed more rapidly and, if human-origin isolates are found, then an immediate follow-up trip will occur so that intensive sampling can be performed in an effort to locate the sources of the human-origin pollution with a combination of source tracking and fluorometry. Filter plates will continue to be sent to the VT lab from the DSS-VDH lab so that source tracking can be performed on the weekly samples as needed.

The two images on the following page show different areas of Fairview Beach.

Image 1. Fairview Beach, showing one of the designated swimming areas. Over half of the beach is under water at high tide (the high tide line is visible in the image).

Image 2. Storm drain and pier at 8th Street, where a public boat ramp is located.

7. Eastern Shore Health District

7. A. Eastern Shore Beaches

The Eastern Shore Health District monitored four different beaches on both the ocean-side (1 beach) and bayside (3 beaches) of the peninsula in 2005. Assateague Beach National Seashore is a large ocean-side beach on the northern part of the peninsula with four sampling locations, evenly distributed down a 4 mile shoreline. Guard Shore beach is a small bayside beach with two sampling locations, also on the northern part of the peninsula. Kiptopeke Beach is found in a state park with the same name on the Chesapeake Bay side of the southern peninsula. Kiptopeke has two sampling locations north of its public boat launch ramp. Cape Charles Harbor is a bayside beach located above Kiptopeke, on the waterfront in the town of Cape Charles. There are four monitoring locations and the beach is bordered on the north by several jetties and storm drain outfalls. The eastern shore beaches were not seriously impacted by Hurricane Isabel in 2003, and there were no advisories in 2004. Microbiological water quality monitoring is performed using membrane-filtration by the DSS-VDH lab in Accomac, VA.

No samples from Assateague National Seashore, Kiptopeke State Park, or Cape Charles exceeded the *Enterococcus* standard for the summer of 2005, and thus no advisories were posted on these beaches. There were two advisories posted at Guard Shore Beach in 2005, one in June and one in July. No fluorescent signal (optical brighteners) was detected in any of the samples obtained monthly from the beaches of the Eastern Shore in 2005 by VT researchers.

Image 1. Assateague Island National Seashore.

On the Assateague National Seashore, the U.S. Park Service provides self-contained sanitary facilities (pumped and hauled on a regular basis) and showers at various locations adjacent to the parking lots, and pets are not allowed on Assateague Island. Trash receptacles are located along the beach and are emptied regularly. There are no piers or structures that might attract shore birds. With dilution and tides from the open ocean, postings should not be an issue at the National Seashore (see picture above).

Image 2. Guard Shore Beach, eastern shore of Chesapeake

Guard Shore is an undeveloped beach that is a favorite with Latin-American migrant workers, mainly on weekends (see picture above). With no services at this beach, both human and dog wastes were observed when sampling after the weekend in 2005, and birds were attracted to the trash left on the beach. People are using rock walls as in the above picture as bathrooms, and waste is washed into the Bay by rainfall and high tides. Periodic postings should be expected on Guard Shore, especially if samples are collected near the weekend when most of the activities on the beach occur. Larger crowds used the beach in 2005, as compared to 2004, and more frequent advisories may occur in the future if this trend continues. Table 1 shows the monthly monitoring results collected by VT staff (average of 3 sites collected near the location of the above picture).

Table 1. Monitoring results for Guard Shore.

Collection Date	Location	Optical Brightener	Tidal Level	cfu/100ml (Ent)
0405	Guard Shore	36	Low-in	83
0505	Guard Shore	43	Low-out	112
0605	Guard Shore	**75**	**High-in**	**287**
0705	Guard Shore	68	Mid-out	154
0805	Guard Shore	**76**	**High-out**	**311**
0905	Guard Shore	54	Low-out	142

The optical brightener results were always negative (below 100). The monitoring results exceeded the standard twice, in June and August, while the regular VDH results showed high counts in June and July. The VDH and VT samples in August were not collected at the same time. High microbial counts with low optical brightener readings indicates that the fecal bacteria are not human in origin. Table 2 provides the source tracking results for Guard Shore. Birds were the largest source of fecal enterococci (46.9%), with wildlife second (34.4%) and dogs third (13.2%). A small human signature was present in June, July, and August (5.5% of total).

Table 2. Microbial source tracking results for Guard Shore.

Collection Date	Location	Bird	Human	Pets	Wildlife	Total
0405	Guard Shore	9	0	1	14	24
0505	Guard Shore	12	0	3	9	24
0605	Guard Shore	14	3	6	4	24
0705	Guard Shore	11	1	3	9	24
0805	Guard Shore	13	4	4	3	24
0905	Guard Shore	10	0	2	12	24
Total	**Guard Shore**	**69**	**8**	**19**	**51**	**144**
%		***46.9***	***5.5***	***13.2***	***34.4***	

Enterococcus isolates were sent to VT by the DSS lab periodically over the summer for source tracking. Those from Guard Shore were classified very similar to the results in Table 2. Isolates from the other three Eastern Shore beaches were all classified as birds or wildlife, although a few isolates from Cape Charles Beach were classified as being from dogs. Kiptopeke State Park provides sanitary facilities and dogs are not allowed on the beach. State Park staff monitor the beach and help maintain a clean beach environment (see following picture). Postings should not be a problem at this beach, and there were no advisories in 2004 or 2005.


Image 3. The beach at Kiptopeke State Park.

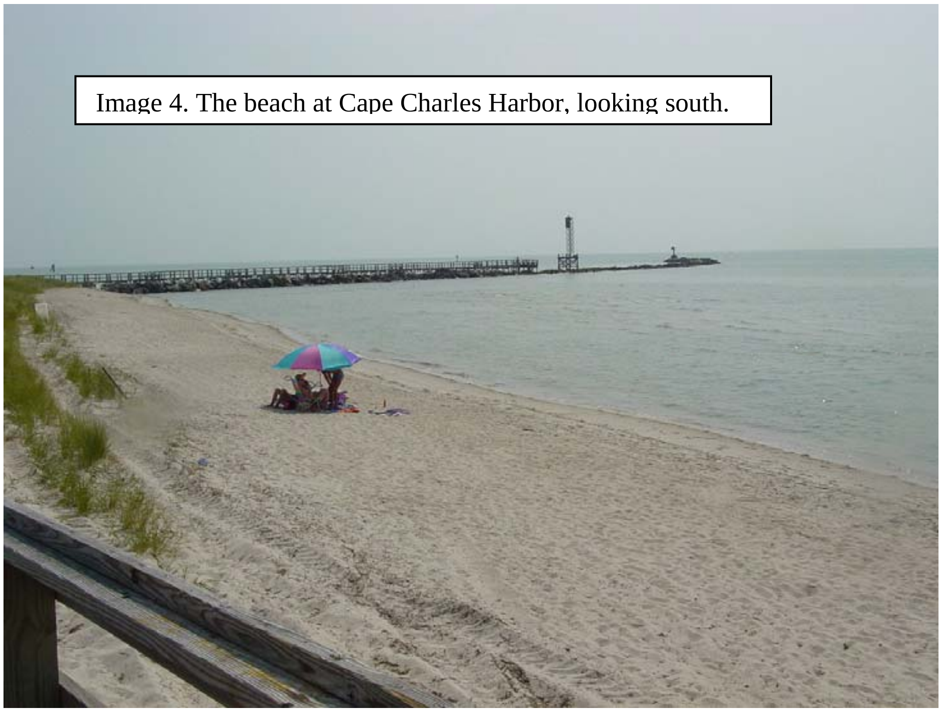


Image 4. The beach at Cape Charles Harbor, looking south.

At Cape Charles Beach sanitary facilities are provided, but dogs are not banned from the beach. However, no dog wastes were observed on the beach during visits by the VT staff in 2005, and the beach is maintained and kept clean (see picture above). However, numerous storm drains enter the water just north of the beach area and water does flow periodically from these drains, especially during storm events. These storm drains could cause problems for Cape Charles Beach in a wet summer, and should be monitored to assess that possibility (see picture below).

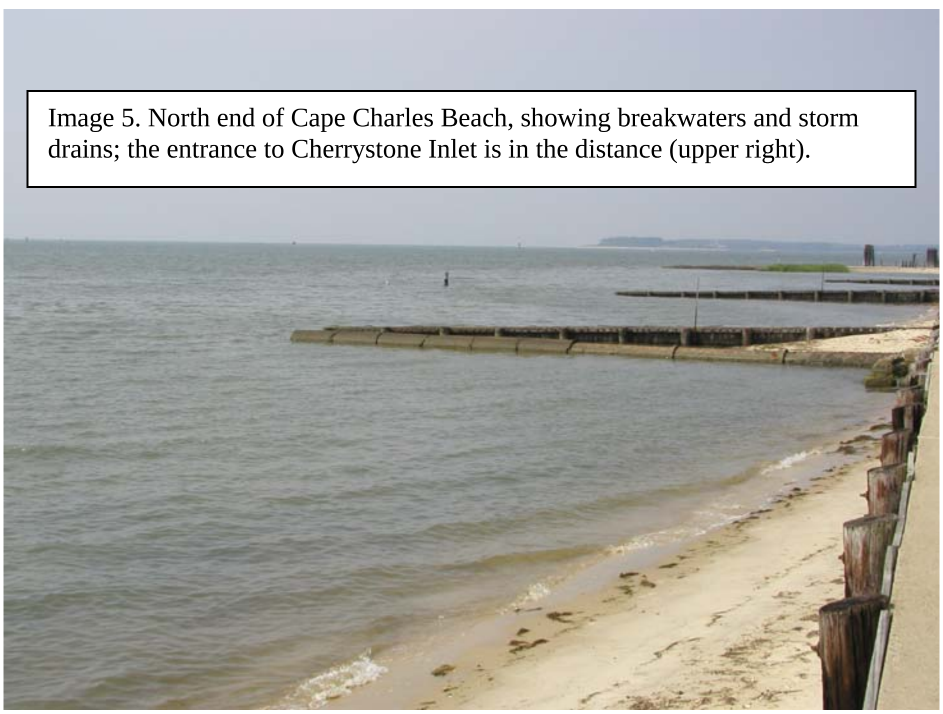


Image 5. North end of Cape Charles Beach, showing breakwaters and storm drains; the entrance to Cherrystone Inlet is in the distance (upper right).

In addition, VDH-DSS samples shellfish monitoring stations that start at the north end of the beach and extend into Cherrystone Inlet. There are shellfish beds in the area around the north end of the beach where the storm drains are located, and these beds are closed to harvest due to fecal pollution (see following picture). This demonstrates that the storm drains are having an impact on water quality in the immediate area where they are located, but have not been a concern further away in the swimming areas up to this point (plus, the regulatory standard for shellfish is much lower than for contact recreation, so it is very feasible to have waters where shellfish harvest is prohibited but swimming is not). Drainage from the storm pipes could be much more of an issue in the swimming areas during a wet summer where larger amounts of contaminated water would be discharged just a short distance north of the beach.

Image 6. Condemned shellfish beds at the north end of Cape Charles Beach.

Plans for 2006 on Eastern Shore Beaches

Minimal monitoring by the VT staff will be necessary on the Eastern Shore in 2006. However, increased observation of Cape Charles Harbor storm drain outfalls should be conducted if the summer of 2006 appears to be wetter than the past two summers. Guard Shore should be sampled more closely, and perhaps a grid system could be used to find the areas with the highest fecal indicator counts. However, the issues at Guard Beach are fairly obvious (lack of facilities, no trash or dog waste collection, a completely unregulated beach, etc.) and a great deal of further research at this location does not appear warranted.